2024 ANNUAL SCIENTIFIC MEETING

JUNE 13-15

Program & Abstracts

UNDERSEA & HYPERBARIC MEDICAL SOCIETY

CROWNE PLAZA NEW ORLEANS FRENCH QTR-ASTOR, NEW ORLEANS, LA

UNDERSEA & HYPERBARIC MEDICAL SOCIETY

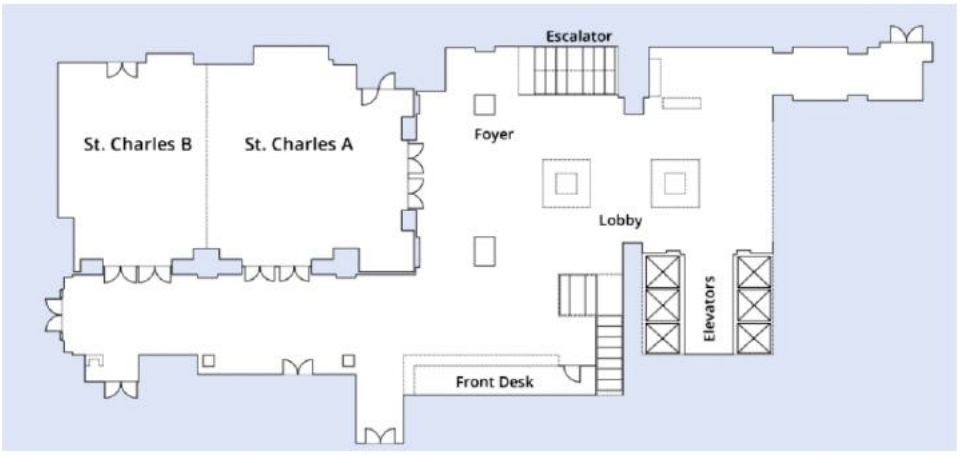
Raising the quality of practice one member at a time

2024
UHMS Scientific Meeting
Program & Abstracts

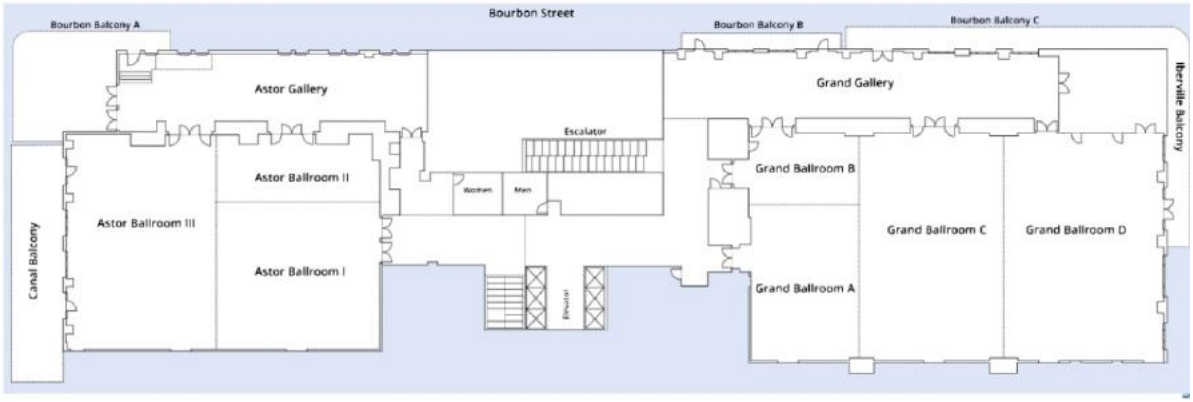
June 13-15

Crowne Plaza New Orleans French Qtr-Astor
New Orleans, LA

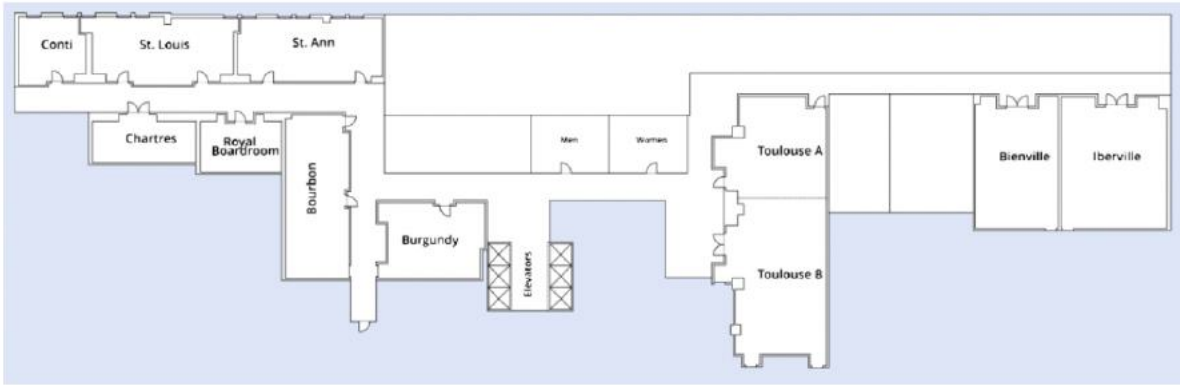
First Floor Lobby Level



Second Floor



Second Floor Mezzanine



Wednesday, June 12:

- Thoracic and Pulmonary Issues in Diving: 8 am-5 pm: Grand Ballroom AB
- Advance in Wound Management: 8 am-5 pm: Grand Ballroom C

Thursday, June 13

- General Session: 8:00 am – 5:30 pm: Grand Ballroom ABC
- Committee Meetings/Luncheons: See schedule.
- STEM Hub: Conti
- Posters: Grand Ballroom D
- Exhibits / Breaks: Astor Ballroom
- Welcome to San Diego: 6 pm-7 pm: Astor Ballroom

Friday, June 14

- General Session: 8 am – 5:30 pm: Grand Ballroom ABC
- Committee Meetings/Luncheons: See schedule.
- STEM Hub: Conti
- Posters: Grand Ballroom D
- Exhibits / Breaks: Astor Ballroom
- Annual Awards Banquet: 7 pm – 10 pm: St. Charles

Saturday, June 15

- General Session: 8 am – 5 pm: Grand Ballroom ABC
- Committee Meetings/Luncheons: See schedule.
- STEM Hub: Conti
- Posters: Grand Ballroom D
- Exhibits / Breaks: Astor Ballroom

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Undersea & Hyperbaric Medical Society
Committees

Board of Directors
Pete Witucki, President
Costantino Balestra, Vice President
Owen O'Neill, President-Elect
Marc Robins, Immediate Past President
Helen Gelly, Treasurer
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Brian Keuski, Member at large
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Julio Garcia, Assoc. Nurse Rep
Elizabeth Smykowski, Assoc. Nurse Rep-Elect*
Daniel Hyun, Assoc. Tech Rep-Elect*
John Peters – UHMS Executive Director*
* (non-voting)

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Bruce Derrick
John Feldmeier
Laurie Gesell
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Hayden Hess
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Julio Garcia, Associates Program
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Thomas Bozzuto & Owen O'Neill, CME Representative
Lisa Tidd, Meeting Planner
Stacy Harmon, CME Coordinator

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Lorrie Cote'
Lora Garrett
Derall Garrett

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Edward L. Beckman: 1969-1970
Heinz R. Schreiner: 1970-1971
Earl H. Ninow: 1971-1972
David H. Elliott: 1972–1973
Johannes A. Kylstra: 1973–1974
Dennis N. Walder, 1974-1975
Peter B. Bennett: 1975-1976
Arthur J. Bachrach: 1976-1977
James Vorosmarti, Jr.: 1977-1978
Herbert A. Saltzman: 1978-1979
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John Hallenbeck: 1982-1983
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Paul Cianci: 1991-1992
Jon T. Mader: 1992-1993
James M. Clark: 1993-1994
Richard E. Moon: 1994-1996
Stephen R. Thom: 1996-1998
Caroline Fife: 1998-2000
Enrico Camporesi: 2000-2002
Neil Hampson: 2002-2004
Lindell K. Weaver: 2004-2006
Bret Stolp: 2006-2008
Laurie Gesell: 2008-2010
Brett Hart: 2010-2012
John Feldmeier: 2012-2014
James Holm: 2014-2016
Enoch Huang: 2016-2018
Nick Bird: 2018-2020
Marc Robins, 2020-2022

Committee Chairpersons
Accreditation Council: Devin Beckstrand
ASM Program: Pete Witucki/Marc Robins
Associates Council: Julio Garcia/Geness Koumandakis
Awards: Tino Balestra
Audit/Finance: Helen Gelly
By-Laws: Owen O'Neill
DCI & Adjunctive Therapy: Richard Moon & Frank Butler
Diving: Charlotte Sadler/Jim Chimiak
Education: Tom Bozzuto & Owen O'Neill
FDA Liaison: John Feldmeier
FUHM: Marc Robins
GME: Tom Masters
Registry: John Kirby
QUARC: Helen Gelly/Stuart Miller
Safety: Andrew Melnyczenko
Hyperbaric Medicine Committee: Marvin Heyboer
Material Testing Advisory (Ad Hoc): Richard Barry
Membership-Chapters/Affiliate: Owen O'Neill
Nominations: Marc Robins
Publications: Matthew Kelly/Dag Shapshak
Research: John Feldmeier/Jay Buckey
Office-based Hyperbaric Medicine: Alan Katz
STEM: Virginia Papadopoulou/Frauke Tillmans

Chapter Presidents
Gulf Coast: Philip Schell
Mid-West: Risa Anderson
Northeast: Zack Gaskill
Pacific: Leo Tanaka

Affiliate Organizations
Canadian Undersea and Hyperbaric Medical Association (CUHMA)
European Underwater and Baromedical Society (EUBS)
Sociedade Brasileira de Medicina Hiperbárica (SBMH)
Società Italiana di Medicina Subacquea ed Iperbarica (SIMSI)
South Pacific Underwater Medicine Society (SPUMS)

SCHEDULE

General Session	Poster Sessions	Exhibits/Breaks/Lunch-Luncheons/ Social Events	Committee Meetings

THURSDAY, JUNE 13			Room
07:00	**17:30**	**Registration**	**Grand Ballroom Foyer**
07:00	**08:00**	**Coffee / Exhibits**	**Astor Ballroom**
07:00	08:00	GME Committee Meeting	Burgundy
07:00	08:00	STEM Breakfast (invite only)	St. Ann
08:00	**08:30**	**Opening Ceremony / Welcome:** UHMS President: Pete Witucki, MD	Grand Ballroom ABC
08:30	**09:30**	**Kindwall Keynote:** New and developing indications for hyperbaric oxygen treatment: Jay Buckey, MD, PHD	Grand Ballroom ABC
09:30	**10:00**	**Break / Exhibits**	**Astor Ballroom**
Session A - HBO_2 Theory and Mechanisms			
10:00	11:30	**Plenary:** International Panel: Diving decompression an actual view: Costantino Balestra, Jack Kot, Jean-Pierre Imbert, Armin Sidali	Grand Ballroom ABC
11:30	**12:00**	**Posters: A4-A6; B7-B8; C35; E66-E67; F103**	Grand Ballroom D

A4: Effective decompression sickness diagnosis: Proof-of-concept machine learning biomarker selection and predictive modelling with blood transcriptome
Presenting Author: Daniel Landry, MD on behalf of Jing Zhang, PhD

A5: Severe Anemia: A case for hyperbaric oxygen therapy during long-distance space exploration
Presenting Author: Andrew Kozminski, MD MSE

A6: Oxy-inflammation after repetitive “open circuit” dives in the Baltic Sea.
Presenting Author: Tommaso Antonio Giacon, MD

B7: Hyperbaric oxygen therapy for treatment-resistant combat-associated PTSD: A randomized, sham-controlled trial
Presenting Author: Keren Doenyas-Barak M.D

B8: Comparison of hyperbaric oxygen treatment pressures for radiation-induced hemorrhagic cystitis
Presenting Author: Riggs Sanchez BA

C35: Genomic expression patterns in recreational divers with type 1 decompression sickness prior to hyperbaric oxygen therapy
Presenting Author: Daniel Landry, MD, CCFP, DRCPSC

E66: Pseudoephedrine prophylaxis does not prevent middle ear barotrauma in hyperbaric oxygen therapy
Presenting Author: Kinjal Sethuraman MD MPH

E67: B Braun Infusomat Space IV Pump Testing in the Hyperbaric Chamber
Presenting Author: Gregory A. Fulmer, BTPS, RRT, CHT

F103: Hyperbaric oxygen therapy for portal venous gas embolism following hydrogen peroxide ingestion.
Presenting Author: Thomas Gregory, MD for Layne Hohn, MS IV

12:00	**14:00**	**Lunch (on own)**	
12:00	13:00	FDA Liaison Committee	St. Louis
12:00	13:00	Education Committee	Burgundy
12:00	13:00	Navy UMO meeting	St. Ann
12:00	13:00	Hyperbaric Medicine Committee	Iberville
13:00	14:00	CAE Steering Committee	St. Louis
13:00	14:00	Research Committee	Bienville
14:00	14:10	**A1:** Environmental study and stress-related biomarkers modifications in a crew during a week of confinement in EMMPOL6 analog astronaut mission: Tommaso Antonio Giacon, MD	Grand ballroom ABC
14:10	14:20	**A2:** Reduction of inflammatory mediators and neutrophil activation by hyperbaric oxygen in patients with decompression sickness or carbon monoxide poisoning: Stephen Thom, MD, PhD	Grand ballroom ABC
14:20	14:30	**A3:** Pressure-related inflammatory responses of SCUBA divers and tunnel workers: Phi-Nga Jeannie Le, MD	Grand ballroom ABC
14:30	15:00	**Plenary:** Top Articles in Hyperbaric Medicine: Emma Rogers, MD: UPenn Fellow	Grand ballroom ABC
15:00	**15:30**	**Break / Exhibits**	**Astor Ballroom**
Session B - Clinical HBO_2			
15:30	16:30	**Plenary:** Panel: Surviving a Medicare audit: Lessons learned: Helen Gelly, MD and Nick Bird, MD	Grand ballroom ABC
16:30	16:40	**B7:** Hyperbaric oxygen therapy for treatment-resistant combat-associated PTSD: A randomized, sham-controlled trial: Shai Efrati, MD presenting on behalf of Keren Doenyas-Barak, MD	Grand ballroom ABC
16:40	16:50	**B8:** Comparison of hyperbaric oxygen treatment pressures for radiation-induced hemorrhagic cystitis: Riggs Sanchez, BA	Grand ballroom ABC
16:50	17:00	**B9:** Assessment of CRAO Cases to Identify Care Improvement Initiatives: Laura M. Lauer, DO	Grand ballroom ABC
17:00	**17:30**	**Posters: B10-B15; B17-B25; B27-B33**	Grand Ballroom D

B10: Physical enhancement of healthy older adults using hyperbaric oxygen: a randomized controlled trial
Presenting Author: Amir Hadanny

B11: Long-term follow-up results for the Multicenter Registry for Hyperbaric Oxygen Therapy
Presenting Author: Jay C. Buckey, M.D.

B12: The effects of hyperbaric oxygen therapy on chronic non-healing wounds using digital planimetry
Presenting Author: Mor Rittblat, MD

B13: Carboxyhemoglobin affected by collection method
Presenting Author: Lindell Weaver, M.D., FACP, FCCP, FCCM, FUHM

B14: Qualitative interviews in a randomized, double-blind trial of hyperbaric oxygen for persistent symptoms after brain injury.
Presenting Author: Rosemary E. Ziemnik, MS

B15: Frequency of urgent consults for hyperbaric oxygen therapy
Presenting Author: Kinjal N Sethuraman, MD, MPH

B16: Hyperbaric oxygen treatment vision study
Presenting Author: Caitlin Costello, BS

B17: Hyperbaric oxygen therapy reduced mortality rate in patients with moderate, severe or critical COVID-19 in a 100 patients compared with reference values
Presenting Author: Jorge Pisarelo, M.D.

B18: Is HBO2 therapy a possible treatment for Long COVID?
Presenting Author: Ida Akkerman

B19: Multicenter Hyperbaric Outcomes Registry: 2023 review
Presenting Author: Jay C. Buckey, M.D.

B20: 10-year outcomes after carbon monoxide poisoning: A retrospective cohort study
Presenting Author: Lindell K. Weaver, MD

B22: Hyperbaric oxygen treatment of mucormycosis: a retrospective case review
Presenting Author: Jason Leddy, BS

B23: Outcomes of hyperbaric oxygen therapy in treatment of invasive fungal sinusitis at a single institution
Presenting Author: Shannon Wheeler, MD

B24: Hyperbaric treatments in sports: Buzz or woe
Presenting Author: Michael B. Strauss MD

B25: A systematic review of iatrogenic air gas embolisms
Presenting Author: Benito Pascua (MD)

B27: Hyperbaric oxygen therapy for soft tissue infections, including gas gangrene, necrotizing fasciitis, and cellulitis.
Presenting Author: Takashi Yamaguchi

B28: Treatment adjuncts to hyperbaric oxygen for treating delayed encephalopathy after acute carbon monoxide poisoning
Presenting Author: Jeffrey Cooper

B29: Reducing incidence of PE tube placement
Presenting Author: Jennifer Wright, CHRN, BSN

B30: Assessment of prevention of middle ear barotrauma in clinical hyperbaric facilities
Presenting Author: Jayesh B. Shah, MD

B31: A physiological model for DCS presentations
Presenting Author: Michael B. Strauss MD

B32: Soft tissue radiation injury and sexual dysfunction; rising curiosity in benefit for HBOT
Presenting Author: Assoc Prof Susannah Sherlock

B33: Text alert notifications and care process model used to increase hyperbaric consultation rate for carbon monoxide poisoning
Presenting Author: Marc Robins, DO, MPH

18:00	**19:00**	**Welcome Reception**	**Astor Ballroom**

FRIDAY, JUNE 14

07:00	**17:30**	**Registration**	**Grand Ballroom Foyer**
07:00	**08:00**	**Coffee/Exhibits**	**Astor Ballroom**

07:00	08:00	Presidents Breakfast (UHMS BOD current & past presidents only)	St. Ann
08:00	09:00	**Lambertsen Keynote:** (Mis)Adventures in the Gulf of Mexico: Sean Hardy, MD	Grand Ballroom ABC
Session C - Decompression Theory and Mechanisms			
09:00	10:00	**Plenary:** Principles of isobaric counter diffusion to prevent DCS: Richard Moon, MD	Grand Ballroom ABC
10:00	**10:30**	**UHMS Exhibits / Break**	**Astor Ballroom**
10:30	10:40	**C34**: First-in-human imaging of venous gas emboli using a capacitive micromachined transducer toward an underwater wearable ultrasound for personalized decompression: Virginie Papadopoulou, PhD	Grand Ballroom ABC
10:40	10:50	**C108:** Innate immune cell responses from elevated pressures and dissolved gases using human lung-on-a-chip devices: Abigail Harrell	Grand Ballroom ABC
10:50	11:00	**C36:** Decompression stops at three instead of six meters of sea water could reduce the risk of decompression sickness: Oscar Plogmark, MD	Grand Ballroom ABC
11:00	11:30	**Plenary:** Imagineering the Future of Diving: Sandra Chapman	Grand Ballroom ABC
11:30	**12:00**	**Posters: C34, C36-C39 & C108**	Grand Ballroom D

C34: First-in-human imaging of venous gas emboli using a capacitive micromachined transducer toward an underwater wearable ultrasound for personalized decompression
Presenting Author: Virginie Papadopoulou, PhD

C36: Decompression stops at three instead of six meters of sea water could reduce the risk of decompression sickness
Presenting Author: Oscar Plogmark,MD

C37: Physiology of deep closed-circuit rebreather (CCR) mixed gas diving: Gas emboli, spirometry and biological changes during a week-long liveaboard safari
Presenting Author: Clément Lévêque, PhD

C38: Decompression gas bubble dynamics in the spinal cord of live rats
Presenting Author: Jens-Christian Meiners

C39: Midpoint assessment: A prospective trial on intra- and inter-subject variability in venous gas emboli and other biomarkers after repeated dives.
Presenting Author: Joshua Currens, BS

C108: Innate immune cell responses from elevated pressures and dissolved gases using human lung-on-a-chip devices
Presenting Author: Abigail Harrell

12:00	**14:00**	**Lunch (on own)**	
12:00	13:00	Safety Committee	Burgundy
12:00	13:00	BNA Luncheon: 12pm-1pm (advance purchase only)	Bienville
12:00	13:00	Publications Committee	Iberville
12:00	13:00	STEM Committee	St. Ann
13:00	14:00	UHMJ Editorial Board	St. Louis
13:00	14:00	QUARC Committee	Burgundy
13:00	14:00	BNA Board meeting	Bienville
Session D - Diving Medicine			
14:00	14:30	**Plenary:** Session D: Commercial diving and DMAC: Phil Bryson, MBBS	Grand Ballroom ABC

14:30	15:00	**Plenary:** Session D: Hard Hat Medicine: The Medical Care of the Compressed Air Tunnel Worker: Owen O'Neill, MD	Grand Ballroom ABC
15:00	15:10	**D40**: Effect of BHB level and gender on latency to CNSOT: Bruce J. Derrick, MD	Grand Ballroom ABC
15:10	15:20	**D41**: No correlation between increases of spleen volume and changes in circulating pro-inflammatory microparticles following fourteen days of apnea and hypoxia exposures: Zac Schlader, PhD	Grand Ballroom ABC
15:20	15:30	**D42**: Dive profiles and DCS rate among seafood harvesters in British Columbia Canada: Sherri Ferguson, MSc	Grand Ballroom ABC
15:30	**16:00**	**Break / Exhibits**	**Astor Ballroom**
16:00	16:30	**Plenary:** Top Articles in Undersea Medicine: Thomas Gregory, MD: Duke Fellow	Grand Ballroom ABC
16:30	17:00	**Plenary:** Decadency/Ascendancy of the LSUHSC Hyperbaric Fellowship Program: A history to die for: Keith Van Meter, MD	Grand Ballroom ABC
17:00	**17:30**	**Posters: D42–D57 & D59**	Grand Ballroom D

D42: Dive profiles and DCS rate among seafood harvesters in British Columbia Canada
Presenting Author: Sherri Ferguson, MSc.

D43: Metabolic profiling of R.O.C Navy divers under simulated diving training: Implications for health and mission preparedness
Presenting Author: Yi-Hao Pan

D44: Arterial/Alveolar pO2 ratio in arterial blood gases of SCUBA divers at depth.
Presenting Author: Tommaso Antonio Giacon, MD

D45: Cutaneous decompression sickness in Cozumel
Presenting Author: Montserrat May Araujo, MD

D46: Thermal perceptions and thermoeffector responses during a progressive cold-water challenge
Presenting Author: Blair Johnson, PhD

D47: Long-term cardiovascular health in divers: A registry-based study on the use of antihypertensive medication among professional divers in Norway
Presenting Author: Tor-Arne Pisani Valen, MD

D48: Selection of pre-dive ketone regimen to evaluate impact of short-term ketosis on latency to CNS O2 toxicity in working divers (KETOX 2)
Presenting Author: Kreager Taber, BA

D49: New methods for head out water immersion in freely behaving rats to study CNS oxygen toxicity
Presenting Author: Courtney Wheelock, PHD

D50: Blood gas parameters from conventional and ketogenic diet dives
Presenting Author: Bruce J. Derrick, MD

D51: Integrated diaphragmatic function, chemosensitivity, and endurance in exercising divers
Presenting Author: Taylor L. Yoder

D52: Increased fat oxidation after combat diver training
Presenting Author: Clara Sjöblom, MSc

D53: Recovery from pulmonary oxygen toxicity: a new (ESOT) model
Presenting Author: Jan Risberg, MD, PhD

D54: Efficacy of Hyperbaric Oxygen Therapy in Cases of Decompression Sickness with Delay to Evaluation
Presenting Author: Thomas J. Gregory, MD

D55: Vital signs monitoring of compressed air workers during hyperbaric interventions in TBM
Presenting Author: Nina Subbotina, MD, PhD, Professor of medicine

D56: Volatile organic compounds in cellular headspace after hyperbaric oxygen exposure; an in vitro pilot study
Presenting Author: Feiko J.M. de Jong, MD

D57: Impairment of cognitive task performance during simulated 10 m dive
Presenting Author: Tatsufumi Fujii, MA

D59: A Retrospective review of diving accidents treated in Puerto Rico from 1997 to 2018
Presenting Author: Richard Fontanez-Aldea, Jack Meintjes, Pedro Arroyo-Ramirez

19:00	**22:00**	**Awards Banquet**	**St. Charles Room**

SATURDAY, JUNE 15

07:00	**16:00**	**Registration**	**Grand Ballroom Foyer**
07:00	**08:00**	**Coffee / Exhibits**	**Astor Ballroom**
07:00	08:00	ACEP Committee Meeting	St. Louis
08:00	09:00	**Davis Keynote:** Non-compliant chambers: Individual liability, and a threat to our industry: Francois Burman, Pr Eng, BSc (Eng), MSc	Grand Ballroom ABC
09:00	10:00	**Plenary:** Randomized controlled blinded trial design & conduct: Challenges-pitfalls-solutions: Dick Clarke, CHT-Admin	Grand Ballroom ABC
10:00	**10:30**	**Break / Exhibits**	**Astor Ballroom**
10:30	11:00	**Plenary:** Shortage of 24/7 Facilities: Jim Chimiak, MD	Grand Ballroom ABC
11:00	11:15	**Plenary:** Mass CO poisoning: Geness Koumandakis, CHT	Grand Ballroom ABC
11:15	12:15	**Plenary**: DCI treatment debate: Shorter oxygen exposures vs US Navy treatment tables: Pablo Medina, MD (Pros) & Richard Moon, MD (Cons)	Grand Ballroom ABC
12:15	13:00	**Plenary:** Tech's going off the reservation: Upholding the CHT Code of Conduct: Dick Clarke, CHT-Admin	Grand Ballroom ABC
13:00	**14:00**	**Lunch (on own)**	
13:00	14:00	UHMS Associate Luncheon: 1pm-2pm (advance purchase only)	St. Charles B
13:00	14:00	REDCap Committee	Iberville
13:00	14:00	UHMS Accreditation Council	Bienville
Session E - HBO_2 Operations, Chambers and Equipment			
14:00	14:30	**Plenary:** Session E: Monoplace hyperbaric chamber, equipment for treating critically ill patients: Lin Weaver, MD	Grand Ballroom ABC
14:30	14:40	**E60:** Improving simulation medical education of providers in hyperbaric medicine: A survey study: Krisos Spyratos, DO	Grand Ballroom ABC
14:40	14:50	**E61-62:** Continuous blood glucose monitor performance in a 100% hyperbaric oxygen environment & Continuous blood glucose monitors and safety in the hyperbaric environment: Enoch Huang, MD & Jacquline Hocking, CHT	Grand Ballroom ABC
14:50	15:00	**E63:** 3D printed IV pass-through for monoplace hyperbaric chambers: Erin Etoll-Jones, MD & Jeffrey Cooper, MD	Grand Ballroom ABC

15:00	15:30	Posters: E60-E65, E68, E70-E72; F74; F76-F83; F110	Grand Ballroom ABC

E60: Improving simulation medical education of providers in hyperbaric medicine: A survey study
Presenting Author: Krisos Spyratos, DO

E61: Continuous blood glucose monitor performance in a 100% hyperbaric oxygen environment
Presenting Author: Enoch Huang, MD

E62: Continuous blood glucose monitors and safety in the hyperbaric environment
Presenting Author: Jacquline Hocking, CHT

E63: 3D printed IV pass-through for monoplace hyperbaric chambers
Presenting Author: Erin Etoll-Jones, MD; Jeffrey Cooper, MD

E64: Delivering hyperbaric oxygen in the COVID-19 Era: The effect of eliminating air breaks on incidence of oxygen toxicity seizure
Presenting Author: Abigail Winn MD

E65: Results of a campaign to improve the knowledge of referring providers related to the benefits of HBO2 therapy on late radiation tissue injury
Presenting Author: William Tettelbach, MD, FACP, FIDSA, FUHM , MAPWCA, CWSP

E68: Investigation of hyperbaric treatment facilities in Canada
Presenting Author: Dr. Kenneth M. LeDez and Dr. Geoff Zbitnew

E70: POCUS in the multiplace chamber
Presenting Author: Christian Repollet Otero

E71: How to survive a medicare TPE: The UCSD and UCLA experience
Presenting Author: Patricia Land, CHT, EMT-B

E72: Operational and patient characteristics of a new, hospital-based hyperbaric facility
Presenting Author: Troy Madsen, MD

F74: Significant cardiac and thrombotic effects of severe carbon monoxide poisoning: A case series
Presenting Author: Margot Samson, MD

F76: Hyperbaric oxygen treatment of hydrogen peroxide enema induced pneumatosis intestinalis and venous gas embolism
Presenting Author: Shane Day, DO, MPH, MS, CPE

F77: Hyperbaric oxygen and fluorescence microangiography in the coordinated management of breast radiation injury
Presenting Author: Margot Samson, MD

F78: A case series of 5 patients with pneumothorax successfully treated with HBO2 without tube thoracostomy
Presenting Author: Abigail Winn, MD

F79: Cold urticaria preventing clearance for scientific diving
Presenting Author: Dan Popa, MD, PhD

F80: A mysterious CAGE and the man inside
Presenting Author: Natalie Ouellette, BSc, MD

F81: Respiratory decompensation during hyperbaric oxygen therapy in a patient with severe aortic stenosis
Presenting Author: Christopher Allen, MD

F82: Hyperbaric oxygen therapy to mitigate anoxic brain injury post-cardiopulmonary arrest
Presenting Author: Alicia Van Doren, MD, MPH

F83: Position change during hyperbaric oxygen therapy for arterial gas embolism
Presenting Author: Naoto Jingami, MD, PhD

F110: Hyperbaric Oxygen for Long-Covid Syndrome, Part II
Presenting Author: Josh White

15:30	**16:00**	**Break**	**Astor Ballroom**
Session F - Top Case Reports			
16:00	16:10	**F73**: Analysis of diver fatalities in San Diego: Insights from the SDDDRC: Benito Pascua, MD	Grand Ballroom ABC
16:10	16:20	**F74**: Significant cardiac and thrombotic effects of severe carbon monoxide poisoning: a case series: Margot Samson, MD	Grand Ballroom ABC
16:20	16:30	**F75:** Sickle cell disease-related SSNHL: A novel HBO2 indication? Natalie Ouellette, BSc, MD	Grand Ballroom ABC
16:30	**17:00**	**Posters: F84-F102, F104-F106 & F109**	Grand Ballroom D

F84: Hyperbaric therapy for a hypertensive pathology: Hyperbaric oxygen therapy in a case of Martorell's hypertensive ulcer
Presenting Author: Thomas J. Gregory, MD

F85: Fulminant decompression illness in a recreational diver without significant omitted decompression.
Presenting Author: Laura M. Lauer, DO

F86: Case report: Hyperbaric oxygen therapy for carbon monoxide poisoning in the third trimester of pregnancy
Presenting Author: Audrey Kim ,MD

F87: Importance of 4-D CT for recurrent hyperparathyroidism in calciphylaxis
Presenting Author: Dr. Kenneth M. LeDez and Dr. Geoff Zbitnew

F88: Hyperbaric oxygen in treatment-resistant eczematous dermatitis
Presenting Author: Dr. Kenneth M. LeDez and Dr. Geoff Zbitnew

F89: An extraordinary carbon monoxide poisoning incident
Presenting Author: Michael B. Strauss, MD

F90: A forefoot mal perforans ulcer challenge
Presenting Author: Michael B. Strauss, MD

F91: Hyperbaric oxygen (HBO2) therapy for penile glans necrosis after non-target embolization: Delayed referrals may still benefit
Presenting Author: Emma M. Rogers, MD

F92: A case report on hyaluronic acid filler embolism treated with hyperbaric oxygen therapy
Presenting Author: Qingle Liu, MD

F93: Improved musculoskeletal pain and range of motion following hyperbaric oxygen treatment for delayed radiation soft tissue injury in two breast cancer patients
Presenting Author: Jay C. Buckey, MD

F94: Subcutaneous emphysema and intraperitoneal bladder rupture due to self-injurious behavior: Treatment experience with hyperbaric oxygen therapy
Presenting Author: Kazuki Yanagida

F95: HBO adjunct treatment for HAPE
Presenting Author: Jayson Malufau DO

F96: Hyperbaric medicine for chronic antibiotic refractory pouchitis: A case study
Presenting Author: Luis Pacheco-Pare to present for Itamar Gnatt, MD

F97: Cutaneous chronic graft-versus-host disease successfully treated with hyperbaric oxygen therapy
Presenting Author: Andrew Moffat, DO

F98: Worsening of cutaneous B-cell lymphoma during a brief course of hyperbaric oxygen therapy
Presenting Author: Matthew P Kelly, MD, FACEP, FUHM

F99: Acute cardiac autonomic dysfunction following acute carbon monoxide poisoning
Presenting Author: Brittany Steinfels, DNP, AGACNP-BC

F100: Human facial canine bite injuries managed with hyperbaric oxygen therapy: A case series
Presenting Author: Raymond C. Shields, MD

F101: Safety of delivering hyperbaric oxygen therapy in a patient with lung transplant: A case report
Presenting Author: Jayanth Adusumalli, MBBS, MPH

F102: Treatment of cricoid chondronecrosis using an unconventional combination of hyperbaric oxygen therapy, tracheostomy and antibiotics
Presenting Author: Jeffrey Cooper, MD

F104: Alcohol intoxication vs decompression sickness
Presenting Author: Christopher Leiker, M.D.

F105: Patient suffering Guillain Barré Syndrome mimicking Neurological Decompression Syndrome
Presenting Author: Richard Fontanez, Pedro Arroyo

F106: Re-entrant ventricular tachycardia needing ablation after carbon monoxide poisoning
Presenting Author: Lindell K Weaver, MD

F109: Compartment Syndrome Neuropathy Resolution with Hyperbaric Oxygen
Presenting Author: Co-author to present for Michael Strauss, MD

Enjoy your last night in New Orleans

Overall Goal of the UHMS Annual Scientific Meeting

The primary goal of the Undersea and Hyperbaric Medical Society ASM is to provide a forum for professional scientific growth and development to the participants. The meeting provides a basis for exchange of ideas, both scientific and practical, among physicians, researchers, and other health professionals. It affords an opportunity for participants to meet and interact with past and present leaders of the Society, and to become active in societal affairs.

CONTINUING EDUCATION

Accreditation Statement:

The Undersea and Hyperbaric Medical Society is accredited by the Accreditation Council for Continuing Medical Education (ACCME) to provide continuing medical education for physicians.

Designation Statements:

- **Physician CME:** The Undersea and Hyperbaric Medical Society designates this live activity for a maximum of **20** *AMA PRA Category 1 Credit(s)™*. Physicians should claim only the credit commensurate with the extent of their participation in the activity.
- **Nursing/RRT Contact Hours:** This live activity is approved for **20** CE hours provided by Florida Board of Registered Nursing/RRT Provider #50-10881. License types: RN, LPN, CNS, ARNP, CNA, CRT, RRT, RCP Provided through the Florida State Board of Nursing and the CE credits are reciprocal and approved for nurses within all states. Receiving credit for Florida providers is simple, attend the course and our staff will upload your credits directly to the Florida State database. For out of state credit, we provide this letter for you to file with the respective nursing board.
- **NBDHMT:** This live activity is approved for **20*** Category A credit hours by National Board of Diving and Hyperbaric Medical Technology, P.O. Box 758, Pelion, South Carolina 29123. ***Up to 10 Cat A credits for** the in-person/live stream meeting and up to **10 Cat A credits for** reviewing poster review/quiz online at your leisure. Not to exceed 20 total maximum Cat A credit hours. **CLICK HERE for approved lectures & posters**.
    - **NBDHMT Accreditation Statement**: For CHT recertification purposes, the NBDHMT requires a minimum of nine of the minimum 12 required Category A credits relate directly to any combination of hyperbaric operations, related technical aspects and chamber safety.

Full Disclosure Statement: Individuals in control of content participating in continuing medical education activities sponsored by Undersea and Hyperbaric Medical Society are expected to disclose to the participants any relevant financial relationships with ineligible companies. Full disclosure of faculty and planner relevant financial relationships will be made at the activity.

Disclosure:
The following individuals have disclosed a relevant financial relationship with ineligible companies. Financial relationships are relevant if the following three conditions are met for the individual who will control content of the education:
A financial relationship, in any amount, exists between the person in control of content and an ineligible company and;

1. The content of the education is related to the products of an ineligible company with whom the person has a financial relationship and;
2. The financial relationship existed during the past 24 months.
3. All of the relevant financial relationships listed for these individuals have been mitigated.

- None of the individuals in control of content (planners/faculty/reviewers/authors) for this educational activity have relevant financial relationship(s) to disclose with ineligible companies whose primary business is producing, marketing, selling, re-selling, or distributing healthcare products used by or on patients.
- The following commercial support was received for this activity.
    - Fink Engineering, unrestricted educational grant $6500
    - Hyperbaric Modular Systems, Inc,. financial support: $2500

Disclaimer: The information provided at this CME activity is for Continuing Medical Education purposes only. The lecture content, statements or opinions expressed however, do not necessarily represent those of the Undersea and Hyperbaric Medical Society.

Note for ABMS Board Certified Physicians: Some ABMS boards will accept accredited CME towards their MOC requirements. As an accredited provider, the UHMS can now register educational activities as CME for MOC (Part II) for ACCME collaborating boards. Please review the learner instructions and submit the necessary requirements for your credit to be reported within 30 days of course closing. Learner CME credit must be reported no later than December 1st of the reporting year. If your board is not collaborating yet with ACCME to report CME for MOC, please continue to submit your credits to your certifying board directly.

Successful completion of this CME activity, which includes participation in the evaluation component, enables the participant to earn up to:

- 20 MOC points in the American Board of Anesthesiology (ABA) Maintenance of Certification (MOC) program; and
- 20 MOC points in the American Board of Internal Medicine's (ABIM) Maintenance of Certification (MOC) program; and
- 20 MOC points in the American Board of American Board of Otolaryngology – Head and Neck Surgery (ABOHNS) Continuing Certification Program (CCP); and
- 20 MOC points in the American Board of Orthopaedic Surgery (ABOS) Maintenance of Certification (MOC) program; and
- 20 MOC points in the American Board of Pathology (ABPath) Continuing Certification Program (CCP); and
- 20 MOC points in the American Board of Surgery (ABS) Maintenance of Certification (MOC) program; and
- 20 MOC points in the American Board of Pediatrics' (ABP) Maintenance of Certification (MOC) program; and
- 20 MOC points in the American Board of Thoracic Surgery (ABTS) Maintenance of Certification (MOC) program.

*****Will require evaluation feedback**

Evaluation: The evaluation will be available at the conclusion of the meeting. To access it, you will need to log in to the UHMS main website with your username and password. Once logged in, you will be able to find the evaluation under the "My Account" tab.

Presentations:
Presentations are also located on the course portal under the "My Account" tab. This meeting is recorded to post as a future enduring material. You cannot claim CE credit for both live stream and enduring material programs.

EXHIBITOR SCHEDULE:
Room: Astor Ballroom

Thurs., June 13: 7 am – 4 pm PT

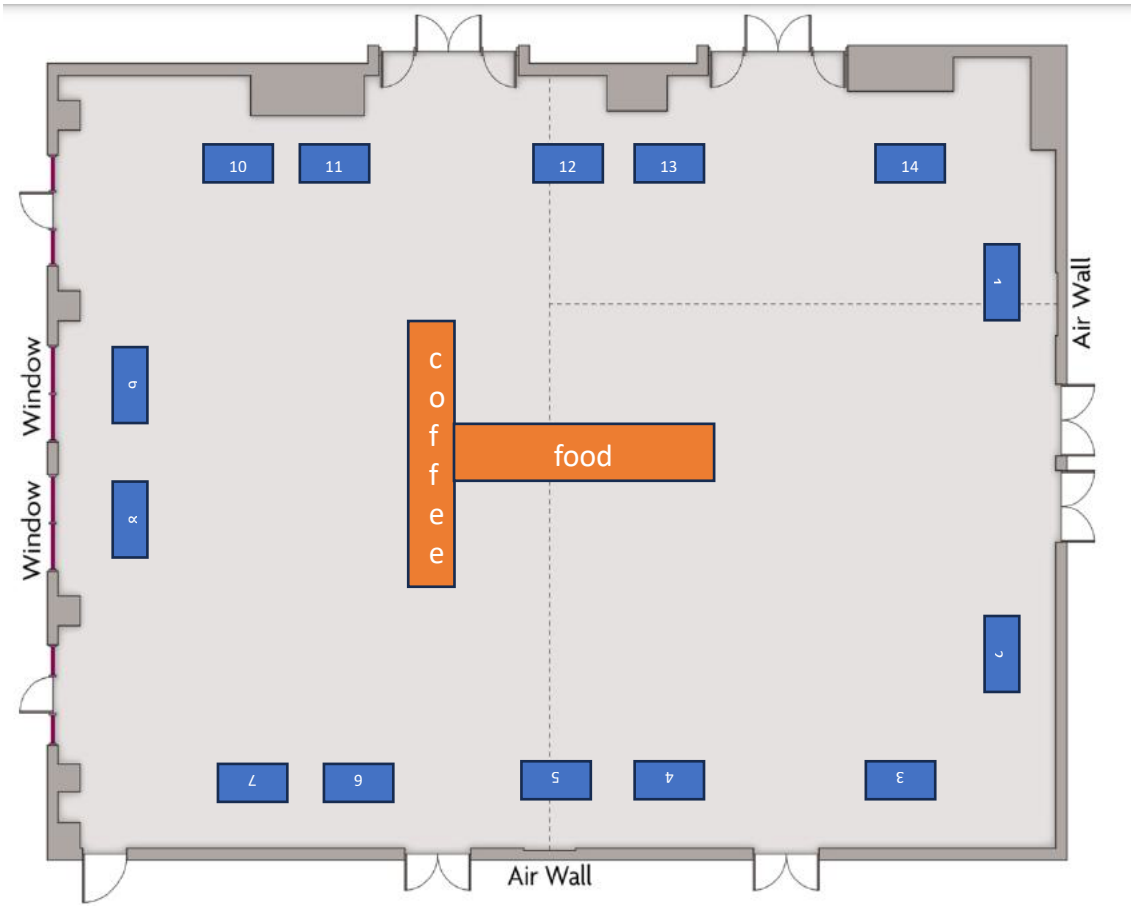
- 7 am - 8 am: Coffee/Exhibits
- 9:30 - 10 am: AM Coffee Break/Exhibits
- 12 pm - 2 pm: Lunch on own
- 3:30 pm - 4 pm: PM Coffee-Snack Break/Exhibit
- 6 pm – 7 pm: Welcome Reception with Exhibitors

Fri., June 14: 7 am – 4 pm PT

- 7 - 8 am: Coffee/Exhibits
- 10 - 10:30 am: AM Coffee Break/Exhibits
- 12:00-2:00 pm: Lunch on own
- 3:30 - 4 pm: PM Coffee-Snack Break/Exhibits

Sat., June 15: 7 am – 12 pm PT

- 7 - 8 am: Coffee / Exhibits
- 10 am - 10:30 am: AM Coffee Break/Exhibits
- 12 pm: Break down begins (out by 4 pm)



SPONSORS

EXHIBITORS

ADVOCATE HEALTH CARE
TABLE 13

3000 W. Montana St., Milwaukee, WI 53215
Email: Christine.McCarrier@aah.org
Website: https://www.advocateauroraclinicianscareers.org/

Advocate Health is the third-largest nonprofit integrated health system in the United States. Headquartered in Charlotte, North Carolina, we have a combined footprint across six states – Alabama, Georgia, Illinois, North Carolina, South Carolina, and Wisconsin. Advocate Health is dedicated to delivering excellent and inspiring health outcomes through research, innovation, and compassion.

AMERICAN BOARD OF PREVENTIVE MEDICINE
TABLE 7

111 West Jackson Boulevard, Suite 1408, Chicago, IL
Email: abpm@theabpm.org
Website: https://www.theabpm.org/

The American Board of Preventive Medicine was established to promote the health and safety of the American people through our high standards in the certification and maintenance of certification in the profession of preventive health.

BAROMEDICAL NURSES ASSOCIATION
TABLE 12

P O Box 53 Gotha, FL 34734
Email: baromedicalnurses@gmail.com
Website: https://hyperbaricnurses.org/

The BNA was established in June 1985 to provide registered nurses practicing in hyperbaric medicine a formal organization within which nurses can develop a network and provide professional support. This organization has grown and expanded outside the boundaries of the United States. Today, the BNA has members in Europe, Asia, South and Central America, and the South Pacific. The BNA remains dedicated to offering educational opportunities, support of nursing research efforts, a presence on Committees and Boards of national organizations, having a public voice in those issues that impact nursing, and providing opportunities for networking and information exchange.

BEST PUBLISHING / WOUND CARE EDUCATION PARTNERS
TABLE 3

631 US Highway 1, Suite 307, North Palm Beach, FL 33408
Phone: 561.776.6066
Email:info@bestpub.com / info@woundeducationpartners.com
Support Email: support@bestpub.com / support@woundeducationpartners.com
Websites: https://bestpub.com/ / https://woundeducationpartners.com/

Best Publishing Company was founded in 1966 and has become the largest and the most respected publishers of educational books on diving, wound care, and hyperbaric medicine. We produce educational books along with professional periodicals such as the Wound Care & Hyperbaric Medicine Magazine, the industry's only free online quarterly publication covering all aspects of wound care, diving medicine, and hyperbaric medicine.

Our Mission is to publish educational books on all aspects of diving, wound care, and hyperbaric medicine. This includes books that are current and innovative, and most importantly, books that will help to promote medical education and diving safety throughout the world.

We distribute our titles to government agencies, hospitals, physicians, libraries, universities, bookstores, commercial dive organizations, sport divers, dive shops, museums, aquariums, and hyperbaric chamber operators around the world.
We value our authors and enjoy promoting their knowledge and vision through their writing. Our team of editors and graphic designers takes pride in producing works that consider our customers' needs.

In 2014, Best Publishing Company joined WCHMedia Group, which houses our sister company and education division, Wound Care Education Partners.

Wound Care Education Partners: We're about science-based, outcomes-driven practice of wound care and hyperbaric medicine at a rate you can afford. Nothing is more powerful than a medical provider with an understated yet absolute confidence in their patient interactions. True confidence in practice comes from a thorough understanding of how, why, and when to treat a patient. Most education companies want you to buy their program at an exorbitant rate and provide you with little support and no human interaction along the way. So, you leave with the CME credits but no real understanding of how to translate what you learned in class to a real-life clinical practice setting. So, how can you have confidence when seeing a patient? Instead, all our faculty and instructors are active practitioners (or recently retired) in their fields of expertise, not just full-time educators. We understand what it's like to be on the front lines, having to make tough decisions and treat patients every day. Here, you'll learn the clinical practice of wound care and hyperbaric medicine through case studies, real-life examples, and evidence-based science from practicing healthcare professionals who are on the front lines every day, just like you.

FINK ENGINEERING PTY, LTD.
TABLE 2

14 Premier Circuit, Warana QLD 4575, Australia
Phone: + 61 7 5438 4900
Email: fink@fink.com.au
Website: https://www.fink.com.au/

Fink Engineering, based in Queensland, Australia, redefines the form and function of medical hyperbaric chambers by combining an innovative design approach with state-of-the-art engineering and fabrication facilities.

Fink Engineering (FE) pioneered the design and development of the rectangular shape for hyperbaric chambers back in 1994 and was the first company internationally to design such a chamber (for the Royal Adelaide Hospital), which has been used effectively ever since. We recognized early on that this shape would ultimately become the standard for all future medical hyperbaric treatment facilities simply because of its user-friendly design if, indeed, we could build them cost-effectively. Our track record proves that we have successfully achieved this goal, with our chambers now operating not only in Australia but also in the USA, Canada, Singapore, New Zealand, and the Middle East, and soon to be in Europe.

HYPERBARIC MODULAR SYSTEMS
TABLE 9

1663 Pacific Rim Ct, San Diego, CA 92154
Phone: 619-336-2022
Email: help@hmschambers.com
Website: www.hmschambers.com

For reliable solutions to your specific needs in clinical hyperbaric oxygen therapy (HBOT), HMS offers extensive experience designing, manufacturing, installing, and maintaining various sizes and configurations of clinical HBOT systems, diving systems and simulators, research incubators and compressed air work (CAW) systems used in tunneling construction projects worldwide. Thank you for visiting our website. We look forward to working with you and delivering a reliable, cost-effective system designed to meet your goals and objectives. You can rely on our decades of professional experience, and accolades in past performances, where HMS chambers are used 24/7/365 in hospitals and medical centers, trauma and burn centers, research institutions, and outpatient wound healing and hyperbaric medicine centers around the world.

KEYSTONE-PHARMACY
TABLE 6

106 Highland Way #206, Madison, MS 39110
Phone: 855-739-9948
Email: brittany@keystone-pharmacy.com
Website: https://keystone-pharmacy.com/

Keystone Specialty Pharmacy is the leading provider in the Southeast US of innovative topical anti-infectives for the treatment of acute and chronic wounds. Our team of consultative clinical pharmacists, along with our industry-leading field sales managers, are exclusively focused on treating wound care patients. We strive to be your trusted partner in healing wounds, specifically customized for your patient based on wound culture results, when available, as well as third-party insurance coverage.

MICROGENDX
TABLE 4

5776 Hoffner Ave #203, Orlando, FL 32822
Phone: 855-208-0019
Email: scott.tucker@microgendx.com
Website: https://microgendx.com/

MicroGenDX specializes in low-cost, highly accurate qPCR + NGS microbial DNA diagnostics — providing answers where cultures or PCR alone have failed.
Mission Statement: MicroGenDX's mission is to improve clinical outcomes by offering clinicians and their patients the most informative and impactful microbial diagnostic tests that science can provide.

Bringing desperately needed advances in diagnostics to providers and patients: Southwest Regional PCR first offered a 2-step process combining qPCR and NGS to identify microbes in 2010 under the commercial name PathoGenius. In 2017, the laboratory was purchased by Rick Martin, head of commercialization for this testing, and rebranded as Southwest Regional PCR dba **MicroGenDX**. Since that new branding and leadership, the laboratory has grown in scale and reach for physicians, specialties, and infection types –nationally and internationally.

A global leader in NGS diagnostics of infection: MicroGenDX laboratory has run over 700,000 next-gen DNA sequencing tests at our state-of-the-art, CAP-accredited, CLIA-licensed molecular diagnostic facility. Our advanced instrumentation, including Illumina Miseq sequencers, provides the industry's most informative microbial diagnostics for ENT/AFB, microbiology laboratories, orthopedics, urology, wound care, podiatry, pulmonary, ExPlants, periodontal, podiatry/nail, OB-GYN, infectious disease, and other medical specialties. Our laboratory is supported by a team of molecular biologists, biochemists, bioinformaticians, computer scientists, and physicians. **MicroGenDX** employs over 200 passionate employees, with a leadership model that swiftly adapts to global health concerns and new technologies. We want to help as many people as possible with microbial identification of challenging infections.

PCCI HYPERBARIC SYSTEMS
TABLE 14

300 North Lee Street Suite 201, Alexandria, VA 22314
Phone: 703-861-8535
Email: https://www.pccihyperbarics.com/contact-us
Website: https://www.pccihyperbarics.com/

PCCI Hyperbaric Systems is a division of PCCI, Inc. solely dedicated to the design, engineering, fabrication, installation, maintenance and repair of hyperbaric chambers (using either oxygen or air), hypobaric chambers, breathing simulators, medical airlocks for Tunnel Boring Machines (TBM), medical air locks, manlocks and related systems for commercial and Government clients. PCCI Hyperbaric Systems division was established to serve the hyperbaric industry by acquiring the assets of Reimers Systems, Inc. and combining it with PCCI's existing hyperbaric systems experience supporting the U.S. Navy. This combined entity provides over 45 years of hyperbaric/hypobaric chambers design, fabrication, installation, and maintenance experience on over 200 monoplace and multiplace chambers.

Our Mission is to exceed industry standards, prioritize occupant safety, demonstrate commitment to best practices, and build upon our globally recognized quality and value in the products and support systems we produce.

PERRY BAROMEDICAL
TABLE 11

3750 Prospect Ave, Riviera Beach, Florida 33404 USA
Phone: 561-840-0395
Sales Toll free: 800-741-4376
Email: Customersupport@perryhbo.com
Website: https://perrybaromedical.com/

Perry Baromedical is a registered medical device manufacturer. Perry Baromedical is an ISO 13485:2016 certified world leader in the manufacture, installation, and service of hyperbaric oxygen therapy systems for medical application. Hyperbaric Oxygen Chambers are United States Food and Drug Administration (FDA) Class II devices and are controlled by federal law. All systems are designed, manufactured, tested, and installed in accordance with the current regulations of the FDA, The American Society of Mechanical Engineers (ASME/PVHO-2) Codes, The Pressure Equipment Directive (CE Mark), Medical Device Directive (CE Mark) and the requirements of the National Fire Protection Agency (NFPA).

RESTORIXHEALTH
TABLE 8

3445 N Causeway Blvd, Suite 600, Metairie, Louisiana 70002 USA
Phone: 877-295-2273
Email: ContactUs@RestorixHealth.com
Website: https://www.restorixhealth.com/

RestorixHealth delivers advanced wound healing services, education, and supplies across the care continuum that improve patient outcomes and quality of life. From developing and operating wound centers in partnership with hospitals to supporting long-term care facilities with education and supplies to providing in-home care, RestorixHealth's solutions increase access to care, reduce hospital admissions, lower or avoid direct care costs, and improve patient and partner satisfaction.

SECHRIST INDUSTRIES
TABLE 5

4225 E. La Palma Ave., Anaheim, CA 92807
1-800-SECHRIST (800-732-4747)
Phone: 714-579-8400
Email: info@sechristusa.com
Website: https://www.sechristusa.com/

World Leader in Hyperbaric and Respiratory Medicine since 1973

Sechrist is a team of dedicated professionals whose purpose is to identify, develop and sustain a worldwide competitive offering of high-quality technology solutions to the healthcare community.

We identify and fulfill healthcare opportunities that will improve the quality of patient care, add convenience and efficiency for the practitioner, and provide high quality and cost-effective technology applications that result in a positive return on investment.

Our team has been building hyperbaric chambers and respiratory products since 1973. The experience our team brings is unsurpassed – many of our team members have been with Sechrist for over 20 years. From the start, we have been customer-driven and operated with a core set of values that define who we are and how we want to be known. These quality-driven values form the foundation of our business and establish a solid presence the world recognizes as Sechrist Industries.

THURSDAY, JUNE 13
GENERAL SESSION

OPENING CEREMONY / WELCOME - UHMS PRESIDENT

8 am – 8:30 am
Pete Witucki, MD

About the Lecture:
Provide an overview of activities, plans, and outcomes from initiatives carried out by UHMS home office, officers, and committees.

About the Speaker:
Dr. Peter Witucki, MD is a Undersea & Hyperbaric Medicine Specialist in San Diego, CA and has over 28 years of experience in the medical field. He graduated from Loyola University of Chicago/Stritch School of Medicine medical school in 1994. He is affiliated with UCSD Medical Center. Dr. Witucki joined the faculty of the Department of Emergency Medicine at UCSD in 2003. He works clinically in the Emergency Dept as well as at the Hyperbaric Chamber and holds board certifications in both specialties. He was a former Diving Medical Officer in the US Navy and has worked with SEALs, Explosive Ordnance Disposal and Submarine Forces in both an active and reserve capacity. He serves on the San Diego Diver Death Review Committee helping to investigate diving deaths in our county. He also serves on the Board of Directors for the Undersea and Hyperbaric Medical Society. His academic and research interests include medial education and diving medicine.

ERIC P. KINDWALL MEMORIAL KEYNOTE
New and developing indications for hyperbaric oxygen treatment

8:30 am - 9:30 am
GUEST SPEAKER: Jay Buckey, MD

About the Lecture:
The talk will provide the evidence for new indications that are developing for hyperbaric oxygen treatment. After attending the lecture, attendees will be familiar with the research and data supporting new indications for hyperbaric oxygen treatment.

Professional practice gap covered:
The gap being addressed here is improving knowledge about when hyperbaric oxygen could be used successfully for new indications where it may not be commonly used currently.
After attending the lecture, attendees will be familiar with the research and data supporting new indications for hyperbaric oxygen treatment.

About the Speaker:
Dr. Jay Clark Buckey, Jr. is an American physician and astronaut who flew aboard one Space Shuttle mission (STS-90) as a Payload Specialist. Buckey holds a Bachelor of Science degree in electrical engineering from Cornell University (1977) and an M.D. from Cornell in 1981, interning at New York Hospital-Cornell Medical Center and completing his residence at Dartmouth-Hitchcock Medical Center. He was also a flight surgeon with the U.S. Air Force Reserve for 8 years. Currently, Dr. Buckey is a Professor of Medicine at the Geisel School of Medicine at Dartmouth and Directs the Hyperbaric Medicine program at the Dartmouth-Hitchcock Medical Center.

ABOUT ERIC P. KINDWALL, MD

Dr. Kindwall is known by many as the "Father of Hyperbaric Medicine." Whether you knew him personally or simply by reputation, we have all benefited from his efforts, passion, wisdom, knowledge, energy and vision. Dr. Kindwall has played a great role in growing and shaping the specialty of Undersea and Hyperbaric Medicine. He was likewise instrumental in molding the UHMS into what it is today. Dr. Kindwall began diving in 1950. He cultivated his interest in the field and during the Vietnam War served as the Assistant Director of the U.S. Navy School of Submarine Medicine. He also was the Senior Officer responsible for the Diving Medicine Program. In 1969, after leaving the Navy, Dr. Kindwall became Chief of the Department of Hyperbaric Medicine at St. Luke's Medical Center, Milwaukee, Wis. Shortly after the Undersea Medical Society was created in the mid-1960s, Dr. Kindwall identified the need for standardized education in the field. He created the UMS Education and Standards Committee to help elevate course content and ensure instructor competence. This committee later became our Education Committee. When the AMA initiated its Continuing Medical Education program, Dr. Kindwall persuaded the organization to recognize the UMS as a grantor of CME credits. In 1972, Dr. Kindwall felt that the Society's members would benefit from improved communication. He created our first newsletter and was named editor. Dr. Kindwall chose the name Pressure because clinical hyperbaric medicine was rapidly developing. Even though the UHMS had not yet incorporated "Hyperbaric" into the Society's name, he wanted a title for the newsletter that would encompass all who worked with increased atmospheric pressure. He stated: "The Society's goal then, as it is now, is to serve all who deal with the effects of increased barometric pressure." That same year, Dr. Kindwall recognized the need to have a relationship with Medicare to help provide insight on reputable clinical management. The UMS followed this lead, and a Medicare Panel was created. The recommendations were presented to the U.S. Public Health Service. The challenge was that no reliable hyperbaric medicine clinical guidelines were available that addressed appropriate applications of Hyperbaric Medicine. To remedy this deficit, the UMS Executive Committee created an Ad Hoc Committee on hyperbaric oxygen therapy. Dr. Kindwall was named Chair. The committee created the first Hyperbaric Oxygen Therapy Committee Report. Again, this text was published 10 years before the UHMS incorporated "Hyperbaric" into its name. The report was sent to HCFA and the Blues and became their source document for reimbursement. Dr. Kindwall updated the text two more times and thus was the Editor and Chair of the Committee and text for three of its 12 editions. Dr. Kindwall later worked to expand the available information on the specialty by creating one of the first complete texts on the field. He created Hyperbaric Medicine Practice in 1994 and later updated and revised his text two more times. The Society's first journal, Hyperbaric Oxygen Review, has also been influenced by Dr. Kindwall. His love for research and education was clear: He became the initial editor, creating a journal that at first consisted of review articles and one original contribution. Over the years, it has grown to one full of original research. Dr. Kindwall's presence is felt in so many of the UHMS' activities and initiatives. Much of what we all take for granted – what is just "there" and "available" – has his touch and influence.

International Panel: Diving Decompression an actual view:

9:30 am – 10 am

Costantino Balestra, Jacek Kot, Jean-Pierre Imbert, and Armin Sidali

About the Lecture

For several years, the Haldanian approach to decompression has been improved after considering data that were not available at the origin of the concept. We will attempt to draw a broad picture of the view, adding some non-Haldanian "ingredients" for future decompression algorithms development. For instance, one can figure out a decompression strategy when planning to run a semi-marathon. He could run the first 5 km rapidly to create a gap and then progressively slow down for the rest of the distance. Alternatively, he could save his resources by starting slowly and afford to run faster at the end of the race. He can decide which strategy to choose if he knows the last 3 km includes a steep climb. With the tendency of individualizing decompression strategies, a lot of personal "receipts" are used; we will try to help everyone to be able to choose a decompression strategy by means of updated knowledge and decompression understanding.

About the Speakers:

Professor Costantino "Tino" Balestra started to study neurophysiology of fatigue then started studies on environmental physiology issues. He teaches physiology, biostatistics, research methodology, as well as other subjects. He Is the Director of the Integrative Physiology Laboratory and a full-time professor at the Haute Ecole Bruxelles-Brabant (Brussels). He is VP of DAN Europe for research and education, Immediate past President of the European Underwater and Baromedical Society.

Professor Jacek Kot is a specialist in anesthesiology and intensive care. He is a full-time Professor in Diving and Hyperbaric Medicine at the Medical University of Gdansk, Poland, also serving as the Chief of Research and Development of the National Centre for Hyperbaric Medicine in Gdynia, Poland. The Centre has several multiplace hyperbaric chambers, a dry saturation simulator with a 'wet pot', and the 6-bed Intensive Care Unit within the University Hospital. Jacek Kot is the present President of the European Committee for Hyperbaric Medicine (ECHM), and from 2015 to 2018, he was the President of the European Underwater and Baromedical Society (EUBS). He has been involved in the international cooperation between European diving and hyperbaric centers (COST-B14, OXYNET, PHYPODE, DAN) and the UHMS International Web-based Education Initiative. His professional interests include mainly HBO2 in deep dives, saturation decompressions, and critically ill patients, especially with severe soft tissue infections.

JP Imbert spent 19 years at Comex, a historical leading diving company, as Diving Manager. He was involved in the Comex research on hydrogen dives and computed the French MT92 tables. He participated to the Norwegian deep projects of the 80's and developed the Comex procedures for saturation to 300 m in Brazil. He then turned to technical diving and became an IANTD instructor in France, training trimix and rebreather divers for 10 years. Back to the offshore industry as a diving consultant, he has since kept editing diving manuals and decompression procedures for the large North Sea companies. He has published on decompression modelling, table validation and recently on divers' monitoring.

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Armin Sidali

Armin Sidali started his career as a mixed gas diver. He then became a technical diving instructor specialized in cave and wreck diving. He was Diving Manager in a small diving company in Barcelona when he conducted the first altitude saturation on a mountain dam in Spain. He got his first experience of hyperbaric interventions during the Barcelona subway Line 2 construction. He has since conducted difficult tunnel interventions around the world. His achievements include the successful completion of the first trimix saturation and the introduction and validation of trimix bounce tables in Hong Kong deep tunnel projects.

Top articles in Hyperbaric Medicine

2:30 pm – 3 pm
Emma Rogers, MD: UPenn Fellow

About the Lecture
Reviewing pertinent articles from 2023-2024.

Professional Practice Gaps covered in lecture:
Professional practice gap covered within your lecture content:

- Knowledge: Pertinent studies, meta-analyses and case reports.
- Competence: How to apply the outcomes and findings of the studies to daily practice in keeping with the principles of evidence-based medicine.

About the Speaker:
Dr. Rogers is a current fellow in Undersea and Hyperbaric Medicine at the Hospital of the University of Pennsylvania. She completed her residency in Emergency Medicine in 2023. She is a Rutgers-Robert Wood Johnson Medical School graduate and an alumna of Cornell University.

Surviving a Medicare Audit – Lessons Learned Panel

3:30 pm – 4:30 pm
Helen Gelly, MD, and Nick Bird, MD

About the Lecture:
This talk provides a summary of a CMS Targeted Probe and Educate audit was weathered, and steps you can take to both reduce your risk and increase your chances of a successful outcome.

Professional practice gap covered: Medicare audit is a frightening reality in today's healthcare setting. Our goal is to orient Hyperbaric physicians to this process and how an audit may be successfully navigated. In addition, education aims to encourage improved documentation which can both improve overall patient care and communication clarity as well as reduce the likelihood of an audit or help to expedite its resolution.

Objectives

- List common errors that may prompt an audit;
- List two diagnoses that CMS no longer covers;
- List at least two actions you can take to reduce audit risk.

About the Speakers:

Dr. Helen Gelly has been involved in hyperbaric medicine and wound care since 1991. She has been actively involved in billing and reimbursement issues for both facilities and physicians. She serves as the Emeritus Medical Director of Hyperbaric Physicians of Georgia, and as C.E.O. for Regenerative and Hyperbaric Medicine.

Dr. Nicholas Bird is a past president of the Undersea and Hyperbaric Medical society, and current medical director of the Center for Hyperbaric Medicine at Virginia Mason Franciscan Health.

Session A - HBO_2 Theory and Mechanisms
ABSTRACTS

A1

ORAL PRESENTATION TIME: Thurs, Jun 13, 14:00 - 14:10
POSTER PRESENTATION TIME: n/a
RESIDENT COMPETITION: Yes

Environmental study and stress-related biomarkers modifications in a crew during a week of confinement in EMMPOL6 analog astronaut mission

Giacon TA[1], Mrakic-Sposta S[2], Vezzoli A[2], Pavanello S[3], Narici M[1], Campisi M[3], Paganini M[1], Camporesi E[3], Foing B[4], Kołodziejczyk A[5,6] Bosco G[1]

[1] Department of Biomedical Sciences, University of Padova,Via Marzolo 3, 35131 Padova, Italy; [2] Institute of Clinical Physiology, National Research Council (IFC-CNR), Piazza dell'Ospedale Maggiore, 3; 20162 Milan, Italy; [3] Department of Environmental Medicine and Public Health, Azienda Ospedale Università Padova, Via Giustiniani 2, 35128 Padova, Italy; [4] LUNEX EuroMoonMars, and EuroSpaceHub Academy, Leiden Observatory Leiden, Netherlands; [5] Space Technology Centre, AGH University of Science and Technology, Kraków, Poland; [6] Analog Astronaut Training Centre, Kraków, Poland

Presenting Author: Tommaso Antonio Giacon, MD
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Introduction/Background

The psychophysical stress response of subjects exposed to confinement in remote locations is of great interest for space exploration and diving operations. Research relies largely on simulations and experimental settings for reliable data to identify which factors most impact physical and cognitive performance.

Materials and Methods

We studied five healthy volunteers who underwent a one-week-long Analog Astronaut training inside a lunar habitat-like facility. They remained completely isolated, without natural light, with high CO2 levels and a large number of tasks to accomplish in a limited time.

Wearable fitness trackers were used to monitor daily step count, physical activity, heart rate during physical exercise and at rest, and sleep parameters. Oxy-inflammation biomarkers and stress and appetite hormones were obtained from daily (T0 to T6) Urine and saliva collection at the time of awakening.

Reactive Oxygen Species (ROS), total antioxidant capacity (TAC), lipid peroxidation (8-iso-PGF2α), DNA damage (8-OH-dG), inflammatory status (IL-6), Creatinine, Neopterine, Uric Acid, Cortisol, Leptin and IGF-1 were measured.

Results

ROS generation was significantly increased between T0 value vs. T6 (+158%). TAC showed a decrease at T6 (-10%), while 8-iso-PGF2α increased at T6 (+49%, compared to T0. IL-6 remained stable. Only salivary Cortisol and not Leptin and IGF-1 showed a significative increase at T6 (+70%). The number of steps did not change significantly during the mission due to the strict physical activity regimen. Sleep duration and quality were both decreased from T1 to T6, respectively (- 81%) and (-57%).

Summary/Conclusion

Confined environment characteristics affected the subjects that showed increased oxidative stress response. Sleep quality and duration could have had a major impact, whilst mitigation strategies such as physical activity and eating habits could minimize the impact on physical performance.

A2

ORAL PRESENTATION TIME: Thurs, Jun 13, 14:10 - 14:20
POSTER PRESENTATION TIME: n/a
RESIDENT COMPETITION: No

Reduction of inflammatory mediators and neutrophil activation by hyperbaric oxygen in patients with decompression sickness or carbon monoxide poisoning

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Introduction/Background
A surprising overlap of inflammatory events involving neutrophils and blood-borne microparticles (MPs) leading to organ injuries has been observed in animal models of acute carbon monoxide (CO) poisoning and decompression sickness (DCS). As both these conditions are treated with hyperbaric oxygen (HBO2), we investigated whether the treatment caused similar alterations of inflammatory mediators in patients by analyzing blood obtained before and after HBO2.

Materials and Methods
Blood was obtained from patients diagnosed with CO poisoning (n=39) and those with DCS (n=20). Samples collected in CytoChex BCT tubes containing a preservative to maintain MPs and neutrophil integrity for at least three weeks were express shipped to the Maryland lab for flow cytometry and ELISA analysis.

Results
Data are presented as % lower values than pre-HBO2. Neutrophils from CO patients manifested lower activation post-HBO2, expressing reduced cell surface CD18 (a β_2 integrin protein; 34.4 $\pm$ 0.05%, SE, $p<0.001$, t-test) and myeloperoxidase (MPO; 26.1 $\pm$ 0.04%, $p<0.02$). Post-CO blood samples exhibited 18.8 $\pm$ 2.8% ($p<0.001$) fewer MPs, which contained 63.8 $\pm$5.5% ($p<0.001$) less interleukin-(IL)-1β. Neutrophils from patients treated for DCS manifested lower cell activation by expressing reduced CD18 (30.0 $\pm$ 0.05%, $p<0.02$) and MPO (27.4 $\pm$ 0.04%, $p<0.05$), and blood had 18.7 $\pm$ 3.4% ($p<0.05$) fewer MPs post-HBO2 which contained 71.0 $\pm$ 7.6 % ($p=0.03$) less IL-1β.

Summary/Conclusion
Activated neutrophils play a prominent role in CO and DCS pathophysiology. These data suggest that HBO2 exerts a suppressive effect on neutrophil activation, causing diminished production of inflammatory MPs, most clearly documented by a reduction in intra-MPs IL-1β. The anti-inflammatory effects of HBO2 have been clearly documented in animal studies, but evidence is less compelling in bona fide clinical care. Reduction of inflammatory mediators ameliorates organ injuries in animal models. Our results provide mechanistic insight into the therapeutic benefits of HBO2 for CO poisoning and DCS.

A3

ORAL PRESENTATION TIME: Thurs, Jun 13, 14:20 - 14:30
POSTER PRESENTATION TIME: n/a
RESIDENT COMPETITION: No

Pressure-related inflammatory responses of SCUBA divers and tunnel workers

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Introduction/Background
Decompression sickness (DCS) and Caisson illness are viewed as synonymous based on their pressure-induced etiology and treatment. However, no direct comparisons of physiological parameters short of overt pathology have been performed. With the growing body of evidence for an immunological basis to DCS, we compared the production of inflammatory microparticles (MPs) and neutrophil activation between eight SCUBA divers working at 14 or 20 feet of seawater (fsw, 1.4 and 1.6 ATA) and 14 tunnel workers exposed to 1.43 ATA.

Materials and Methods
Blood obtained from divers and tunnel workers collected into CytoChex BCT tubes containing a preservative were express shipped to Maryland for flow cytometry and ELISA analysis.

Results
Statistically significant elevations (all $p \leq 0.02$) for total MPs as well as MPs subgroups expressing proteins specific to neutrophils, endothelium, platelets, astrocytes, and microglia occurred post-pressure exposure in SCUBA divers and tunnel workers. The elevation magnitudes were the same in both groups. For example, divers total MPs/µl plasma increased by 27.5±8.1 (SE)%; tunnel workers increased by 27.4±6.8% (NS; not significantly different). Neutrophil CD66b protein-expressing MPs in divers increased by 43.9±10.0%, and tunnel workers increased by 41.8±7.5% (NS). Similar elevations were found for MPs expressing inflammatory filamentous actin (55.4±16.8% for divers, 39.3±8.1% for tunnel workers (NS) and thrombospondin-1 (39.8±9.6% for divers, 46.2±9.4% for tunnel workers (NS)). Post-pressure exposure elevations of neutrophil activation parameters (CD18 and myeloperoxidase) were also similar between groups. Notably, while the diver's exposure at depth averaged 36.0±4.8 minutes, the average exposure for tunnel workers was 3.1±0.5 hours ($p \leq 0.02$).

Summary/Conclusion
These results demonstrate consistent physiological responses associated with human exposure to elevated pressure. However, the marked difference in exposure times suggests that inflammatory responses are rapidly saturable, consistent with ex vivo studies of inflammatory MPs production by neutrophils (see J Biol Chem 289: 18831, 2014).

A4

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Thurs, Jun 13, 11:30-12:00
RESIDENT COMPETITION: No

Effective decompression sickness diagnosis: Proof-of-concept machine learning biomarker selection and predictive modelling with blood transcriptome

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Introduction/Background
Diagnosis of decompression sickness (DCS) remains a daunting issue in military, commercial, scientific, and sport diving, as the symptoms of DCS are varied and not entirely explained by the ischemia-reperfusion model. Therefore, an objectively measurable biomarker-based diagnostic system is desirable. Modern Next Generation Sequencing (NGS)-based methods like RNA-seq have enabled systematic survey of transcriptome on an "OMICS" (genomics, proteomics, metabolomics, metagenomics, phenomics, and transcriptomics) level. Recent advancements in machine learning (ML)-oriented data science are revolutionizing OMICS biomedical research, specifically for biomarker discovery and predictive modeling for diagnostic purposes. This study explored the use of blood transcriptome profiles and ML to identify DCS signatures and build a proof-of-concept classification ML model for DCS diagnosis.

Materials and Methods
Baseline peripheral blood transcriptomic profiles were established for 21 recreational divers with DCS using total RNA RNA-seq on an Illumina HiSeq platform. The most important transcriptomic DCS signatures and a subsequent ML predictive model were established by cross-validation with a recursive random forest and support vector machine (CV-rRF-FS-SVM) algorithm.

Results
The ML analysis identified protein-coding genes and other transcriptomic signatures that are most important to separate DCS status from the baseline condition. Selected genes may be involved in potential DCS onset responses. For example, *KLRD1* and *PRF1* are related to immunoinflammatory responses, and ADGRG1 and CPSF7 are involved in cell proliferation and DNA damage responses (e.g., damage repair). Using these signatures, we subsequently developed a prototype ML model for DCS prediction with good performance (ROC-AUC, or Receiver Operating Characteristic-Area Under Curve, on holdout test data=0.82).

Summary/Conclusion
These results demonstrated the potential and feasibility of using AI/ML-molecular OMICS for DCS diagnosis. In particular, the latter could serve as a foundation for establishing an effective AI-assisted DCS determination solution, ultimately leading to a more objective, enhanced DCS diagnosis, prognosis, treatment planning, and prevention.

A5

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Thurs, Jun 13, 11:30-12:00
RESIDENT COMPETITION: Yes

Severe anemia: A case for hyperbaric oxygen therapy during long-distance space exploration

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Introduction/Background
Hyperbaric oxygen therapy (HBO2) can treat severe anemia in cases where blood transfusion is refused or logistically unfeasible. Humans exploring space are at risk of trauma and hemolytic anemia without readily available blood products. Using an extravehicular mobility unit (EMU) as a pressure vessel could help treat anemic astronauts at 1.12 and 1.56 ATA, depending on their starting exploration atmosphere and habitat capabilities. This work aims to examine the utility of the EMU in giving HBO2 for severe anemia in space.

Materials and Methods
Oxygen consumption after hematologic insult was calculated from average oxygen delivery over a range of hemoglobin (Hgb) concentrations, 1-15 g/dL. Change in oxygen debt accumulation was calculated with and without a pressurizable module to 1 atm, then with 100% oxygen via face mask or through the EMU (respective pressures of 0.56, 1.12, 1, and 1.56 ATA). The frequency of treatments was capped at cumulative unit pulmonary toxic doses (UPTD) of 1425.

Results
Oxygen debt accumulated when Hgb fell below 4.2 g/dL. In a 0.56 atm habitat, with Hgb of 4 g/dL, the EMU prolonged the buildup of critical oxygen debt (22 L/m^2) by 168 hours over 13 treatments. The face mask prolongs by 388 hours over 95 treatments. At Hgb 3 g/dL, the EMU prolongs this for 33 hours. In a 1 atm habitat, the EMU maintains noncritical oxygen debt for 179 and 32 hours, at Hgb 4 and 3 g/dL, respectively; face mask for 191 and 34 hours at Hgb 4 and 3 g/dL, respectively.

Summary/Conclusion
HBO2 reduces oxygen debt per treatment compared to a face mask and allows for longer air breaks. Therefore, HBO2 has greater utility than 100% oxygen via face mask at Hgb 3 g/dL or less.

A6

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Thurs, Jun 13, 11:30-12:00
RESIDENT COMPETITION: Yes

Oxy-inflammation after repetitive “open circuit” dives in the Baltic Sea.

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Introduction/Background
Background. SCUBA diving involves exposure to a hyperbaric environment that can induce oxidative stress and inflammation. This study investigates the evolution of the oxy-inflammation status in divers who performed repetitive dives in cold water.

Materials and Methods
Methods. In the Baltic Sea, nine expert divers were recruited to perform five dives (from T1 to T5). Urine and saliva were collected before (A) and after (B) each dive. Reactive Oxygen Species (ROS), total antioxidant capacity (TAC), lipid peroxidation (8-iso-PGF2α), DNA damage (8-OH-dG), inflammatory status (IL-6), nitric oxide metabolites (NOx) neopterin, and electrolyte balance changes were investigated.

Results
Results. ROS generation was significantly increased between T1A value vs. T4A (+45%) and T5A (+89%). Compared to T1B, ROS increased at T4B (+83%) and T5B (+146%). 8-iso-PGF2α increased at T5A (+65%) respect T1A and T3A (+48%) and at T5B (+59%) respect to T1B. 8-OH-dG showed an increase at T4A (+49%) and T5A (+61%) T1A, and at T5B, (+41%) respecting T1B. TAC showed a decrease at T4B (-15%) and T5B (-24% respect T1B. IL-6 increased at T5A (+183%) concerning T1A and T5B (+154%), respecting T1B.

Summary/Conclusion
Conclusion. Repetitive dives in cold water induced a progressive increase in pre-dive ROS, 8-iso-PGF2α, 8-OH-dG. Oxidative stress was contained by activation of endogenous antioxidant defenses, while IL-6 variation resulted from diving-related physical effort. We did not find notable changes in electrolyte balance, probably because all subjects examined were well-trained and experienced divers.

Session B – Clinical HBO_2
ABSTRACTS

B7

ORAL PRESENTATION TIME: Thurs, Jun 13, 16:30 - 16:40
POSTER PRESENTATION TIME: Thurs, Jun 13, 11:30-12:00
RESIDENT COMPETITION: No

Hyperbaric oxygen therapy for treatment-resistant combat-associated PTSD: A randomized, Sham-controlled trial

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Introduction/Background
Long-standing symptoms of post-traumatic stress disorder (PTSD) are associated with changes in brain activity. Cumulative data indicate that a dedicated protocol of hyperbaric oxygen therapy (HBO2) may induce neuroplasticity and improve the clinical symptoms of patients suffering from PTSD. The aim of the current study was to evaluate the effects of HBO2 on treatment-resistant combat-associated PTSD (tr-caPTSD) in a randomized, placebo-controlled trial.

Materials and Methods
Male veterans aged 25-60 years with tr-caPTSD were included. Exclusion criteria included a history of traumatic brain injury, other psychiatric diseases, or contraindication to HBO2. Participants were randomly assigned to HBO2 or sham intervention. Both interventions involved 60 daily sessions, with 90 minutes of either 100% oxygen at 2ATA (HBO2 group) or 21% oxygen at 1.02ATA (sham group) with five-minute air brakes every 20 minutes. Clinician-Administered DSM-V PTSD scale score (CAPS-V) was the primary endpoint, and resting-state functional(f) MRI was assessed at baseline and post-treatment.

Results
Fifty-six veterans completed the study protocol (28 in each group). The HBO2 group showed significant improvement in CAPS-V score, from 42.57±9.29 at baseline to 25.8±9.5 following HBO2 (Ps of fMRI demonstrated improved connectivity between both thalami and fronto-parietal network and between the right anterior prefrontal cortex and the salience network in HBO2 vs. Sham groups.

Summary/Conclusion
Dedicated HBO2 protocol can improve the post-traumatic symptoms of veterans suffering from tr-caPTSD. The clinical improvement was accompanied by enhanced functional connectivity demonstrated by fMRI.

B8

ORAL PRESENTATION TIME: Thurs, Jun 13, 16:40 - 16:50
POSTER PRESENTATION TIME: Thurs, Jun 13, 11:30-12:00
RESIDENT COMPETITION: No

Comparison of hyperbaric oxygen treatment pressures for radiation-induced hemorrhagic cystitis

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Introduction/Background
Kidney, bladder, and prostate cancer rates have increased worldwide. The treatment includes radiotherapy (RT), which may result in irradiation damage to bladder epithelium. 3-6.5% of these patients develop radiation-induced hemorrhagic cystitis (RIHC), presenting from 6 months to 20 years post-radiation treatment. The complications of RIHC result in 7% of emergency urology admissions and can lead to urinary diversion and cystectomy in refractory cases, which carries a 44% mortality rate. Hyperbaric oxygen therapy (HBO2) is a recommended treatment for RIHC, promoting tissue healing and angiogenesis. Response rates of HBO2 in patients with RIHC have reported rates from 80%-100%. Despite high success, there is no definitive knowledge of the ideal treatment pressure, duration, or number of treatments. This project aimed to determine the difference in outcome for patients treated at 2.4 and 2.0 ATA (atmospheres absolute).

Materials and Methods
A retrospective chart review was performed of all 53 patients who received HBO2 at Nebraska Medicine between 2014 and 2023. Outcomes were based on changes in cystitis symptoms.

Results
Treatment showed symptom improvement rates of 93.5% and 86.4% for 2.4 and 2.0 ATA treatments, respectively, with no statistically significant difference. Overall, 90.5% of patients showed clinical improvement, which was higher than the average improvement reported in the literature. Of the cohort, five patients (9.4%) had no improvement, and 17 patients (32.1%) had a clinical recurrence of symptoms prompting alternative treatments.

Summary/Conclusion
The study concluded that HBO2 showed success rates similar to or better than those published in the literature and that the current methods effectively treat RIHC. No significant comorbidities were identified, and no temporal variables were significant. Although there was no statistical difference in outcomes for patients treated at different pressures, a trend towards higher pressure was identified.

B9

ORAL PRESENTATION TIME: Thurs, Jun 13, 16:50 - 17:00
POSTER PRESENTATION TIME: n/a
RESIDENT COMPETITION: Yes

Assessment of CRAO cases to identify care improvement initiatives

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Introduction/Background
Central retinal artery occlusion (CRAO) is a visually devastating condition with limited effective treatment**.** Hyperbaric oxygen therapy (HBO2) has been shown to improve visual outcomes in some patients. This retrospective, observational cohort study aims to define patient selection criteria further and identify areas to optimize care.

Materials and Methods
We performed a retrospective, observational analysis of patients treated at our institution for CRAO with at least one HBO2 treatment between July 2011 and December 2023. We defined visual improvement as a decrease in LogMAR by >/= 0.3 based on visual acuity on the initial exam and upon completion of HBO2. We attempted to correlate visual improvement with demographics, comorbidities, delay to treatment, concurrent treatments, and findings on dilated funduscopic exams.

Results
In a sample of 79 patients, there were 28 females, 51 males, and an average age of 66.2 years. The median number of HBO2 treatments was 3. An improvement of >/=0.3 LogMAR was seen in 43% with a mean of 0.31 LogMAR +/- 0.67. There was a statistically significant improvement in patients treated within 24 hours, with a trend toward benefits up to 40 hours. Twenty-three percent of patients had a concomitant stroke, and 7.3% had a future stroke within the enrollment period. There was no correlation with demographics, comorbidities, initial visual acuity, or fundoscopic exam findings.

Summary/Conclusion
Patient selection for treatment of CRAO remains challenging, and there are often delays in initiating HBO2. Clarifying appropriate patient selection criteria and education for patients and community providers is essential to optimize care, decrease morbidity and efficiently utilize resources.

B10

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Thurs, Jun 13, 17:00-17:30
RESIDENT COMPETITION: No

Physical enhancement of healthy older adults using hyperbaric oxygen: A randomized controlled trial

Hadanny A[1,2], Sasson E[1], Copel L[3], Daniel-Kotovsky M[1], Yaakobi E[1], Lang E[1], Fishlev G[1], Polak N[1], Friedman M[1], Doenyas-Barak K[1], Finci S[1], Zemel Y[1], Bechor Y[1], Efrati E[1,2,4,5]
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Introduction/Background
Aging is associated with a progressive decline in physical activity capacity. The objective of the current study was to evaluate the effect of an intermittent HBO2 protocol on maximal physical performance and cardiac perfusion in normal, non-pathological, and non-athletic aging adults.

Materials and Methods
A randomized controlled clinical trial randomized 56 healthy adults (> 64yrs) either to HBO2(n=27) or control arms(n=29) for three months. The primary endpoint included the VO2Max on the E100 cycle ergometer. Secondary endpoints included cardiac perfusion, evaluated by magnetic resonance imaging and pulmonary function. The HBO2 protocol comprised of 60 daily sessions, breathing 100% oxygen at 2ATA for 90 minutes with 5-minute air breaks every 20 minutes.

Results
Following HBO2, notable improvements were observed in VO2Max/kg, with a significant increase indicated by a net effect size of 0.439 (p=0.02). Additionally, oxygen consumption measured at the anaerobic threshold (VO2AT) showed a significant increase (effect size for MBF was large at 0.7 (p=0.01), while the net effect size for MBV was even larger at 0.912 (p=0.006).

Summary/Conclusion
The findings of the study indicate that HBO2 has the potential to improve physical performance in healthy aging adults. The enhancements observed encompass improvements in key factors, including VO2 max, power, and the anaerobic threshold. An important mechanism contributing to these improvements is the heightened cardiac perfusion induced by HBO2.

B11

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Thurs, Jun 13, 17:00-17:30
RESIDENT COMPETITION: No

Long-term follow-up results for the Multicenter Registry for Hyperbaric Oxygen Therapy

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Introduction/Background
The Multicenter Registry for Hyperbaric Oxygen Therapy collects pre- and post-treatment data about outcomes, treatment, and complications from hyperbaric oxygen (HBO2) treatment. Initially, the registry did not include follow-up measures after patients completed treatment, but this has been established at Dartmouth-Hitchcock and Duke University Medical Center.

Materials and Methods
Patients provide their preferred e-mail address (or mail address if they prefer not to use e-mail) at the time of consent. Hyperbaric satisfaction and visual change questionnaires were developed. Patients receive them on five occasions from 3 to 51 months post-treatment, in addition to any indication-specific questionnaires they completed during treatment. Most questionnaires are sent via e-mail through the REDCap database that houses the registry, which allows patient responses to be entered directly into the database. Paper questionnaires are entered manually.

Results
253 patients have been enrolled in long-term follow-up. Eighty-eight questionnaires have been returned although not all patients answered all questions. The median value on the question of whether HBO2 was effective was 75 (range 0-100, std 34.1) (where 0=not at all, and 100=very effective), with the most common response being 90-100 (“very effective”). The median on the question of whether their condition was better at follow-up was 75 (range 0-100, std 24.9) (where 0=much worse, and 100=much better), with the most common response being 90-100 (“much better”). There was considerable variability in the responses. On the visual change questionnaire at 15 months after treatment 6/11 (54%) of responders to this question said their vision had returned to the pre-treatment state.

Summary/Conclusion
The long-term follow-up program offers the opportunity to gather information on the durability of benefits from hyperbaric oxygen treatment. The registry also offers the ability to determine which factors and conditions are associated with good long-term outcomes. An ongoing problem will be the response rate.

B12

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Thurs, Jun 13, 17:00-17:30
RESIDENT COMPETITION: Yes

The effects of hyperbaric oxygen therapy on chronic non-healing wounds using digital planimetry

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Introduction/Background
Nonhealing wounds (NHW) can arise when the healing process is stalled due to multiple factors, including diabetes and peripheral vascular disease (PVD), among others. Hyperbaric oxygen therapy (HBO2) has been suggested to have a positive effect on wound healing, irrespective of the wound's origin, in both preclinical and clinical studies. However, the objective effects of HBO2 as an adjunct therapy using digital planimetry have yet to be investigated in a large-scale study.

Materials and Methods
A retrospective analysis was conducted on patients with NHW treated with at least 20 HBO2 sessions and had digital wound documentation between 2003 and 2022 in a single center, the Sagol Center for Hyperbaric Medicine and Research, Israel. Patients were considered for treatment after a transcutaneous oxygen pressure (TcPO2) compatibility assessment, which included both room air and hyperbaric conditions. Digital photos of the wounds at baseline and at the last HBO2 sessions were evaluated by a single evaluator using digital photo planimetry software.

Results
The study included 458 patients (73.4% males) with a mean age of 66.41±12.66. Of them, (31067.7%) suffered from diabetes, 277 (60.5%) suffered from PVD, and 197 (43%) patients sustained both comorbidities. The mean total area of wounds decreased after HBOT from 16.11±23.36 cm^2 to 10.23±15.13 cm^2 with a mean wound size reduction rate of 63.81% ($p<0.001$). Granulation, fibrin, and necrosis areas decreased after HBO2 as well ($p<0.001$). Wound size at baseline was the most significant predictor of wound healing and size reduction ($p < 0.001$), whereas age, sex, HBO2 number of sessions, and wound etiology were not significant predictors.
Summary/Conclusion
HBO2 induces significant objective improvements in NHW in both wound size reduction and wound component changes. The selection of NHW for HBO2 should be based on wound size and TcPO2 compatibility. Furthermore, digital photo evaluation can be used to assist in objective evaluations of wound healing.

B13

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Thurs, Jun 13, 17:00-17:30
RESIDENT COMPETITION: No

Carboxyhemoglobin affected by collection method

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Introduction/Background
Carbon monoxide (CO) poisoning is confirmed or suspected by elevation in carboxyhemoglobin (COHb). Previously, we reported three cases of false COHb, which led to changes in care.1 To facilitate hyperbaric medicine consultation for possible CO poisoning, Intermountain Health began a system whereby hyperbaric medicine physicians are notified by text when the COHb >5% in non-smokers and >10% in smokers. From these alerts, we observed several cases of apparent false elevations of COHb in those with COHb between 5 and 10%. Respiratory Care operates the COHb-oximeters. They mentioned that they frequently observe COHb values higher when blood is collected in lithium-heparin vacutainers rather than standard blood gas syringes. We decided to compare COHb when collected by both methods.

Materials and Methods
Blood was obtained from intensive care patients with indwelling arterial catheters in lithium-heparin vacutainers (mint-colored; Becton Dickinson) and lithium-heparin blood gas syringes. Co-oximetry was done shortly thereafter using the ABL800 blood gas analyzer (Radiometer, Copenhagen, Denmark).

Results
Twenty-nine paired COHb samples were obtained, one by blood gas syringe and the other by vacutainer. By syringe, the mean ±1 SD COHb was 1.40 ± 0.6; by vacutainer, 2.61 ± 0.9 ($p<0.001$). In two samples, the syringe COHb were 1.5% and 1.1%; the vacutainer COHb were 5% and 5.1%, respectively. When re-analyzed 45±18 minutes later, the COHb by syringe was 1.50 ± 0.6; by vacutainer was 3.52 ± 0.9 ($p<0.001$).

Summary/Conclusion
These data and our clinical observations support that COHb should be obtained by blood gas syringes intended for that purpose. The use of lithium-heparin vacutainer tubes results in COHb values higher than from blood collected in blood gas syringes. Also, a delay in COHb measurement elevates the COHb collected by vacutainers but not by blood gas syringe. Inaccurate COHb may lead to changes in clinical management.

B14

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Thurs, Jun 13, 17:00-17:30
RESIDENT COMPETITION: No

Qualitative interviews in a randomized, double-blind trial of hyperbaric oxygen for persistent symptoms after brain injury

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Introduction/Background
We conducted a double-blind randomized trial of Hyperbaric Oxygen (HBO2) after brain injury.[1,2]

Materials and Methods
Adult participants with persistent symptoms from non-stroke brain injury were randomized to receive 40 one-hour blinded (Hyperbaric oxygen-HBO2 or sham sessions) in a monoplace chamber over 12 weeks, followed by 40 HBO2 sessions in a multiplace chamber. Five in-person assessments were administered. A structured interview with free-response answer choices was administered at study completion (≥12 months). Blinded chamber sessions were individually scheduled; open treatment sessions were held at a fixed time in the afternoon, Monday through Friday. Assessments were conducted during standard business days/hours, as well as on occasional weekends and holidays.

Results
Of the forty-seven randomized participants (45% male, mean age 47), 37 (22 HBO2, 15 Sham) completed the exit interview.

Thirty-four (91.9%) participants endorsed ≥1 benefit from study participation, and 3 participants (all HBO2) did not.

	80 HBO_2 Sessions *n* (%)	40 HBO_2 Sessions *n* (%)
Benefit source		
Chamber sessions	16 (73)	12 (80)
Interactions with staff/ other participants	10 (46)	6 (40)
Type		
Quality of life	16 (73)	8 (53)
Cognition	12 (55)	9 (60)
Mood	10 (46)	6 (40)
Challenges		
Time commitment	12 (55)	11 (73)
Work accommodation	9 (41)	5 (33)
Transportation	6 (27)	6 (40)
Schedule	7 (32)	4 (27)
Learning	19 (86)	13 (87)
Brain injury or treatments	10 (46)	6 (40)
Insight into own abilities/symptoms	8 (36)	3 (20)

Summary/Conclusion
Most participants reported benefits from participating in the study, including improvement in symptoms, unstructured social interactions, and gaining new knowledge related to brain injury or additional insights into their own symptoms. The time demands of the study, necessity for work accommodations, mid-day chamber sessions, and transportation to and from the study sites were common challenges.

[1]Weaver UHMS abstract 2023
[2]Ziemnik UHMS abstract 2023

B15

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Thurs, Jun 13, 17:00-17:30
RESIDENT COMPETITION: No

Frequency of urgent consults for hyperbaric oxygen therapy

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Introduction/Background
Multiple time-sensitive indications exist for hyperbaric oxygen treatment. Despite this, few 24/7/365 hyperbaric chambers are available in the United States (US), and there are only nine active Emergency Medicine ACGME-accredited fellowships. Our objective was to report the frequency, complications, and outcomes of urgent HBO2 consultations.

Materials and Methods
We utilized the International Multicenter Registry for Hyperbaric Oxygen Therapy, which started in July 2011 and captures data from 26 hyperbaric centers across several countries. Each center inputs de-identified data of all patients referred for HBO2 consultation into a central Research Electronic Data Capture (REDCap) registry and is expected to report 95% of its cases. The registry collects patient demographics, indications, treatment details, complications from HBO2, and outcomes.

Results
A total of 2634 patients were included, mostly from the US (88.4%). Common emergency indications for HBO2 were carbon monoxide (CO) toxicity (27.4%), compromised grafts and flaps (26.0%), necrotizing soft tissue infections (NSTI) (15.7%), and idiopathic sudden sensorineural hearing loss (ISSNHL) (11.6%). The most frequently reported complications for these indications were claustrophobia, otic barotrauma, and the need for ear tubes or myringotomy. Different outcome measures were used for each indication. The most common resolved symptoms of CO toxicity were headache (41.7%), dizziness (32.6%), and nausea/vomiting (31.6%). The prevalence of necrosis and duskiness before HBO2 in compromised grafts and flaps decreased from 27.8% and 49.1% to 11.8% and 9.9%, respectively. The average wound size in patients with NSTI decreased from 280x157x51 mm to 254x142x41mm. All components of the EQ-5D score, which assesses quality of life, improved in patients with ISSNHL.

Summary/Conclusion
Several emergency indications for HBO2 exist. Improved access to hyperbaric chambers to treat these cases in a timely manner would improve clinical outcomes.

B16

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Thurs, Jun 13, 17:00-17:30
RESIDENT COMPETITION: No

Hyperbaric oxygen treatment vision study

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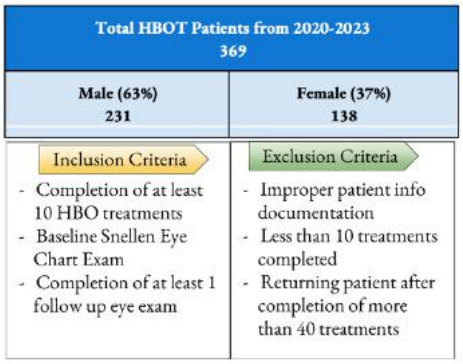
Introduction/Background

Temporary vision changes are a known complication of Hyperbaric Oxygen Treatment (HBO2). Most commonly, patients become more myopic. Hyperbaric patients are typically told that these changes will occur after about 20 treatments and are more common in patients over the age of 45. Current research shows that vision changes due to HBO2 are temporary, but the potential for permanent changes is unknown. It is essential to better understand the timeline of vision changes due to HBO2 and the associated risk factors in order to fully inform patients prior to treatment.



Materials and Methods

The Centers for Disease Control and Prevention platform Epi Info 7.2 was used to collect and analyze data. Patient information was collected from their charts, and the initial visual change during eye exams was documented. As part of an ongoing Quality Improvement project, visual acuities were documented at the beginning of a hyperbaric treatment course, approximately every ten treatments, and then at the end of the treatment protocol.

Results

85% of patients experienced visual changes, often at ten treatments.

Treatment Number of Initial Visual Change	Frequency	Percent	Wilson 95% Confidence Interval
10	183	58.28%	[52.76, 63.60]
20	93	29.62%	[24.84, 34.89]
30	23	7.32%	[4.93, 10.75]
40	15	4.78%	[2.92, 7.73]
Total	315	100.00%	—

Figure 2.
Treatment Number of Initial Visual Change
Frequency and percentage of patients who experienced visual changes at 10, 20, 30, or 40 treatments.

Treatment Depth (ATA)	Visual Change Occurrence	Wilson 95% Confidence Interval
1.5	87.50%	[47.35, 99.68]
2.0	85.33%	[78.64, 90.57]
2.4	84.88%	[79.23, 89.49]
Other	100.00%	[54.07, 100.00]

Figure 3. Visual Change Occurrence at HBO Treatment Depths

Summary/Conclusion

Our findings conclude that 85% of patients experience visual changes. Of those with visual changes, most experienced them within the first 10-20 treatments, showing that the eye lens is affected relatively early within the course of HBO2. Additionally, treatment depth did not show a strong correlation with visual changes.

B17

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Thurs, Jun 13, 17:00-17:30
RESIDENT COMPETITION: No

Hyperbaric oxygen therapy reduced mortality rate in patients with moderate, severe or critical COVID-19 in 100 patients compared with reference values

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Introduction:
Significant morbidity and mortality resulted from COVID-19 infection during 2020. In this paper, we report our experience with HBO2 in the treatment of COVID-19 patients classified by severity based on reference classifications to test HBO2's efficacy in their treatment.

Materials and Methods
From July 1 through October 31, 2020, one hundred COVID-positive patients with moderate, severe, and critical presentation classified according to NEWS2 and CURB-65 criteria received hyperbaric oxygen therapy in a multiplace chamber in addition to conventional treatment. Mortality rates for each group and survival were analyzed and compared to reference values published (CURB-65) and official national and local mortality rates reported without HBO2

Results:
Comparison of predicted mortality (%) reported by CURB-65 vs. study group was 27.8 vs. 16.6, 27.8 vs. 16.8, 14 vs. 8.5, and 6.8vs 5.88 for stages 5 (critical), 4 (critical), 3 (grave) and 2 (moderate) respectively. National reported mortality for patients admitted to the hospital was 17%, and the local province was 25% compared to 11% of the study group. In addition, patients classified as critical according to News2 and recommended admission to intensive care were treated in a regular ward.

Conclusions:
Hyperbaric oxygen therapy reduced the mortality rate in patients with moderate, severe, or critical COVID-19, as compared to reported values in groups of patients not treated with HBO2. The effects of HBO2 in the experimental group reduced the need for referral to the ICU and the use of ventilator assistance.

References:

- https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8086802/
- https://www.researchgate.net/publication/347537853_Ambulatory_patients_with_coronavirus_disease-19

B18

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Thurs, Jun 13, 17:00-17:30
RESIDENT COMPETITION: No

Is HBO2 therapy a possible treatment for Long COVID?

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Introduction/Background
In the aftermath of the COVID-19 pandemic, it became clear that some patients remain symptomatic even months after their initial infection. This is now referred to as Long COVID. Symptoms of Long COVID are, among others, fatigue, breathing problems, sleep problems, weakness, and memory problems. A definite treatment is not yet available. However, hyperbaric oxygen therapy (HBO2) seems promising. Since 2022, HBO2 has been an off-label treatment for Long COVID patients in the Netherlands. This retrospective study presents the first results of the patients treated in our center.

Materials and Methods
Patients who completed the 40 treatments (5 per week) were included. The Checklist Individual Strength (CIS) was administered before the start, after 10, 20, 30, and 40 sessions, and 2 and 6 months after the last HBO2 treatment.

Results
A total of 30 patients completed the 40 sessions. After 40 treatments, the mean total score decreased from 111.8 to 83.3. Statistically significant improvements were also found in the concentration, motivation, and exercise sub-scores. The number of persons that met the reference values for chronic fatigue (total score higher than 113 and fatigue sub score above 51) decreased from 13 to 4 and 15 to 4, respectively.

The generalized estimation equation (GEE) of the score as a function of time and score at the start showed a statistically significant average decline of 4.8 points per week of treatment.

Summary/Conclusion
The major drawback of this survey is the lack of a control group. However, the average duration of a Long COVID condition before the start of therapy is almost two years. It is unlikely that these decreases in CIS scores (and thus in health complaints) were due to the passing of time alone. Therefore, HBO2 treatment shows a promising decline in health complaints in Long COVID patients.

B19

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Thurs, Jun 13, 17:00-17:30
RESIDENT COMPETITION: No

Multicenter Hyperbaric Outcomes Registry: 2023 review

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Introduction/Background
The Multicenter Registry for Hyperbaric Oxygen Therapy is designed to provide key data on outcomes and complications from hyperbaric oxygen (HBO2) treatment. These data are important for providers, insurers, and patients. The Registry collects data on all patients seen (both for UHMS-approved and non-approved indications) in participating units. The data from participating centers are aggregated to provide unique information.

Materials and Methods
Defined outcomes data were collected from all patients evaluated at participating centers and entered into a REDCap database. Patients at all centers completed the same questionnaires and had the same outcome measures recorded. The registry is governed by a steering committee composed of representatives from each participating center.

Results
Currently, 29 centers are actively entering patient data, and additional centers are working through the enrollment process. A total of 9236 individual patient records are recorded in the registry, with 2499 entries in 2023. The top three indications in 2023 were delayed radiation injury (N=439; 28%), carbon monoxide (N=224; 14%), and compromised grafts/flaps (N=198, 12%). The top three non-UHMS indications were “other” (n=17), COVID-19 (N=13), and ulcerative colitis (N=6). Statistically significant pre- to post-changes in outcomes exist for most common indications.

Summary/Conclusion
An outcomes registry offers a consistent method for collecting evaluation and treatment results for patients with both UHMS-approved and emerging indications. Participating centers are entering information into this registry, and their de-identified data are being pooled to provide larger datasets of outcomes than any individual center could accumulate over time. These data are essential for refining existing indications, developing new ones, detecting treatment trends, documenting complications, and tracking outcomes over time. New centers are encouraged to join the registry. A key requirement is that data be entered on all patients.

B20

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Thurs, Jun 13, 17:00-17:30
RESIDENT COMPETITION: No

10-year outcomes after carbon monoxide poisoning: A retrospective cohort study

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Introduction/Background
Mining of large population datasets has revealed long-term health consequences of carbon monoxide (CO) poisoning. Prior analyses (Undersea Hyperb Med 2021; 48(3):330 and 2022; 49(1): 98-9) used patients with influenza or gastroenteritis as controls, which may not be optimal. We analyzed 10-year outcomes using shoulder dislocation to identify controls.

Materials and Methods
We identified patients aged 18-70 years with CO poisoning or shoulder dislocation without concussion presenting to emergency departments between 2000 and 2013. We excluded admitted patients. We identified patients who died within ten years of the visit and occurrence of diabetes mellitus, heart disease, stroke, deep venous thrombosis or pulmonary embolism, multiple sclerosis, hypothyroidism, or bowel disease before and up to 10 years after the visit of interest. Only patients without a prior diagnosis were considered in the analysis for each condition. Chi-squared tests were used for univariate analyses.

Results
We identified 1617 patients with CO poisoning (57% male, mean age 36±13 years) and 9932 controls (81% male, mean age 35±14 years).

Patients with CO poisoning were more likely to die in the ten years following their emergency department visit than controls (5.9% vs 3.4%, odds ratio (OR) 1.76, 95% confidence interval (95% CI) 1.39-2.22, p<0.001).

Other 10-Year Outcomes:

New Condition	CO	Controls	OR (95% CI)	Significance
Diabetes mellitus	5.5%	3.3%	1.72 (1.35-2.20)	p<0.001
Heart disease	4.7%	3.5%	1.36 (1.06-1.76)	p=0.02
Stroke	0.4%	0.2%	2.16 (0.91-5.12)	p=0.07
DVT/PE	2.5%	2.2%	1.16 (0.83-1.64)	p=0.39
Multiple sclerosis	0.9%	0.2%	4.25 (2.20-8.20)	p<0.001
Hypothyroidism	6.3%	3.3%	1.95 (1.54-2.47)	p<0.001
Bowel disease	11.0%	5.7%	2.05 (1.71-2.46)	p<0.001

Summary/Conclusion
In this retrospective cohort study, non-admitted patients with CO poisoning had higher rates of death and developing diabetes mellitus, heart disease, multiple sclerosis, hypothyroidism, and bowel disease over 10 years than patients seen in emergency departments for shoulder dislocation.

B22

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Thurs, Jun 13, 17:00-17:30
RESIDENT COMPETITION: Yes

Hyperbaric oxygen treatment of mucormycosis: A retrospective case review

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Introduction/Background
Invasive infections from mucor fungi are associated with high mortality even with prompt, aggressive multimodal therapy. Hyperbaric oxygen therapy (HBO2) is one adjunctive therapy, but the ideal strategy for incorporating HBO2 is unknown. Our review investigated demographic factors and evaluated the management of patients treated for mucormycosis with HBO2.

Materials and Methods
We completed an IRB-approved, retrospective chart review of eight patients treated for mucormycosis infections with HBO2 at a single multi-place chamber over six years.

Results
All patients were immunocompromised – five had uncontrolled diabetes, two had leukemia, and one took mycophenolate and tacrolimus for renal transplant. The most common symptoms were unilateral vision loss, facial hemiplegia, pain, and headache. Six patients had rhino-cerebral-orbital spread, and two patients with leukemia had disseminated infections. All patients received amphotericin, with most undergoing multiple debridement procedures. All patients received 100% oxygen at 2.4 ATA for 90 minutes for an average of 26 treatments. An average of 43.5 days elapsed from symptom onset (23 days from diagnosis) to the first HBO2 treatment. Five of eight patients achieved clinical improvement, undergoing an average of 37 treatments. The two patients with disseminated mucor presented 9 and 23 days from diagnosis, but HBO2 was deemed non-beneficial after an average of 4.5 sessions. One patient with dural invasion declined debridement or HBO2 after 16 sessions, pursuing only antifungal therapy. Another patient experienced infection complications despite completing 40 treatments initiated within 16 days of diagnosis. Two patients experienced ear barotrauma, and one noted chest pain during HBO2.

Summary/Conclusion
All five patients who achieved clinically stable or resolving infections completed a minimum of 24 HBO2 sessions starting an average of 29.8 days after diagnosis, suggesting a possible lower limit of treatment duration to see clinical benefit. Further research is necessary to establish the optimal implementation of HBO2 for invasive fungal infections.

B23

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Thurs, Jun 13, 17:00-17:30
RESIDENT COMPETITION: Yes

Outcomes of hyperbaric oxygen therapy in treatment of invasive fungal sinusitis at a single institution

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Introduction/Background
Information on the utility of hyperbaric oxygen treatment (HBO2) for invasive fungal sinusitis (IFS) is limited, in part based on the rarity and mortality of the disease. HBO2 has been shown to exert antimicrobial, immunomodulatory, and angiogenic properties, lending it useful for multiple indications related to hypoxia and infection. In this report, we describe our institutional experience to provide further data as to potential indications for its use in IFS, a potentially lethal disease that almost exclusively affects immunocompromised individuals, with mortality rates of up to 50% to 80%.

Materials and Methods
We performed a retrospective case series at an academic tertiary referral center. We reviewed clinical records from patients treated for IFS with adjunctive HBO2 from 2017 to 2022. Variables recorded included comorbidities, pathogen, HBO2 regimen, complications, additional interventions, and follow-up. The outcomes evaluated were morbidities and mortality.

Results
In our series, four patients were identified who had IFS and underwent adjunctive HBO2. All four pathogens were identified as aspergillus, and all underwent operative debridement, ranging from one to four surgeries, as well as treatment with antifungals. Every patient survived and was discharged following HBO2, which ranged from 10 to 28 sessions. One patient was neutropenic upon presentation and required granulocyte infusions throughout HBO2. Another patient with a history of heart disease developed pulmonary edema during treatment, and three patients required myringotomy placement for barotrauma prophylaxis. Follow-up ranged from three to 14 months, all without evidence of recurrence.

Summary/Conclusion
HBO2 is a safe intervention that should be considered an adjunct to the treatment of IFS. It was found to be particularly beneficial in patients with IFS secondary to aspergillus who did not respond to the standard treatment of surgical debridement and antifungal therapy or who were awaiting recovery of immune function.

B24

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Thurs, Jun 13, 17:00-17:30
RESIDENT COMPETITION: Yes

Hyperbaric treatments in sports: Buzz or woe

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Introduction/Background
The use of hyperbaric oxygen (HBO2) in sports is controversial. The buzz is its potential in hastening recovery & improving performance. There are observations, applicable mechanisms, and laboratory studies to support this. The woe is that it is preferentially available to the elite, and its use is mostly unregulated. This presentation discusses its buzz & woes

Materials and Methods
The literature and our studies have established four hyperbaric (HB) sports applications: injury recovery, mitigating delayed-onset muscle soreness (DOMS), performance enhancement, and energy recovery. Three of the four relate to injury, activity, recovery, and the fourth to improving performance. We confirmed that there is a lack of professional guidance on its usage and the readily available purchase of HB chambers.

Results
Injury recovery has the most supporting information for sports uses of HBO2. An observational study (Scott 1993) showed a 47% percent reduction in recovery time in football [soccer] injuries in the HBO2 cohort. Benchwork (Yagishita) has confirmed clinical observations. While the literature is mixed, our studies showed no benefit of HBO2 for DOMS and non-statistical improvement in resistance exercise performance, but none in strenuous running activity. A woe is in the use of HBO2 for the vague de-energetic symptoms. No regulations exist for the sale of HB units. More than 20 manufacturers offer these units for home (air) or athlete trainer facilities (subclinical HBO2) use.

Summary/Conclusion
Whereas the mechanisms of HBO2 are applicable to the recovery of sports injuries, the physiological justification for using it in other applications remains to be elucidated. More research is warranted for HBO_2 in sports medicine, especially those with head and spinal cord trauma. Finally, regulations and guidance for overt “off-label” uses are essential before a private use disaster occurs and unrealistic, oppressive regulations are enacted.

B25

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Thurs, Jun 13, 17:00-17:30
RESIDENT COMPETITION: Yes

A systematic review of iatrogenic air gas embolisms

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Introduction/Background
There is insufficient literature on the incidence, prevalence, and treatment of iatrogenic arterial gas embolisms (iAGE). These embolisms, arising from various medical procedures, can lead to severe and even fatal consequences. Updates on the incidence of such occurrences may increase awareness of what procedures more commonly lead to this adverse event. Medical education inadequately addresses iAGE, resulting in a lack of awareness among practitioners.

Materials and Methods
A systematic review following PRISMA guidelines was conducted to quantify iAGE occurrences in the current literature. Two researchers independently screened and extracted data from eligible titles and abstracts. All available literature on the PubMed database, up to December 31st, 2023, was searched using the terms “iatrogenic gas embolism” and “iatrogenic air embolism.” Case reports and series available in English were included, while experimental, animal, and non-iatrogenic studies were excluded.

Results
A search yielded 286 articles, with 171 excluded based on criteria. 115 articles met inclusion, detailing 1600 iAGE cases. The most common causes were heart surgery, extracorporeal circulation, and esophagogastroduodenoscopy. Hyperbaric oxygen therapy (HBO2) was administered in 585 cases, with varying outcomes.

Summary/Conclusion
Our review underscores the underreporting of iAGE cases in the medical literature. Education, prompt identification, and early hyperbaric oxygen therapy may prevent morbidity and mortality. Further tracking of this diagnosis is advocated. The hyperbaric medicine community's shift toward an international registry may enhance understanding. We posit that iAGE incidence surpasses current estimates. iAGEs are likely under-recognized and pose significant risks when untreated. Early recognition and HBO2 are crucial for management. Enhanced education and a national registry are recommended to mitigate periprocedural mortality.

B27

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Thurs, Jun 13, 17:00-17:30
RESIDENT COMPETITION: No

Hyperbaric oxygen therapy for soft tissue infections, including gas gangrene, necrotizing fasciitis, and cellulitis

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Introduction/Background
Hyperbaric oxygen therapy (HBO2) for soft tissue infections has been extensively reported, and there is abundant evidence supporting its efficacy. In our facility, we actively incorporate HBO2 treatment alongside antimicrobial therapy and surgical interventions for conditions such as gas gangrene, necrotizing fasciitis, and cellulitis. In this presentation, we reflect on the treatment outcomes of soft tissue infections treated with HBO2 at our institution.

Materials and Methods
For gas gangrene, HBO2 was administered 1-210 times (median 22.5 times) in 60 cases. For necrotizing fasciitis, HBO2 was administered 1-198 times (median 28 times) in 26 cases.

Results
Results of Gas gangrene: limb salvage in 29 cases, amputation in 14 cases, three deaths, and four cases transferred to another hospital. The mortality rate was 5%, and the amputation rate was 23.3%. Results of NF: limb salvage in 15 cases, amputation in six cases, no deaths, and four cases transferred to another hospital. The amputation rate was 23.1%.

Group A Streptococcus, also known as "Flesh-eating bacteria," can sometimes cause fatal necrosis. In our experience, S. pyogenes was detected in one case of gas gangrene and five cases of necrotizing fasciitis. Despite fewer cases of necrotizing fasciitis compared to gas gangrene, the detection of S. pyogenes was noteworthy. The prognosis of cases where S. pyogenes was detected resulted in one case transferred due to septic shock, one case of toe amputation, and four cases of limb preservation.

Summary/Conclusion
Bacterial culture tests typically take about a week to yield results, leaving antibiotic sensitivity unclear during treatment. In contrast, HBO2 is believed to complement antibiotic therapy by supplying excessive oxygen, inhibiting bacterial growth through oxygen toxicity, and promoting leukocyte killing, even against anaerobic bacteria. Therefore, in suspected cases of necrotizing soft tissue infections, initiating HBO2 early, without waiting for bacterial culture results, may help reduce the risks of mortality and amputation.

B28

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Thurs, Jun 13, 17:00-17:30
RESIDENT COMPETITION: No

Treatment adjuncts to hyperbaric oxygen for treating delayed encephalopathy after acute carbon monoxide poisoning

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Introduction/Background
Hyperbaric oxygen (HBO2) is often employed in the treatment of severe carbon monoxide (CO) poisoning in the acute setting to lessen the risk of delayed neurological sequela (DNS) and for the treatment of such sequela. Limited data exists on possible adjuncts to HBO2 therapy for the treatment of CO poisoning and the treatment of DNS. We review a few published clinical trials that compare HBO2 monotherapy to HBO2 plus an adjunctive treatment in the DNS setting.

Materials and Methods
A review of clinical trials investigating treatment adjuncts to HBO2 for improving outcomes in the setting of CO poisoning.

Results
Only four clinical trials analyzing an adjunctive therapy to HBO2 were identified. The experimental groups in all four studies, HBO2 + N-butylphthalide (NBP), HBO2 + dexamethasone (DXM), HBO2 + NBP + DXM, and HBO2 + DXM + intravenous (IV) mannitol, had significantly higher post-treatment mini-mental status exams (MMSE) than the control HBO2 monotherapy group. The HBO2 + NBP, HBO2 + DXM, and HBO2 + DXM + IV mannitol studies also measured the post-treatment remission rates, and these were significantly higher in the experimental groups compared to the control group (47.9% vs 33.3%, 41.6% vs. 23.3% and 46.2% vs. 24.4%, respectively). Side effects were similar between control and experimental groups for all studies. Interestingly, all four studies lacked adequate descriptions of their inclusion and exclusion criteria and methods. The timing of the intervention and the signs, symptoms, and clinical data for entry into the studies were unclear.

Summary/Conclusion
In these trials, adjunctive treatment with NBP or DXM demonstrated superior efficacy to HBO2 monotherapy alone, and none resulted in significant side effects. These adjuncts may be reasonable options in the setting of DNS from CO poisoning. Our center is starting a randomized, double-blind, controlled study of DXM as an adjunct to HBO2 for acute CO poisoning.

B29

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Thurs, Jun 13, 17:00-17:30
RESIDENT COMPETITION: No

Reducing the incidence of PE tube placement

Wright J
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Introduction: A common adverse event among patients receiving Hyperbaric Oxygen Therapy (HBO) is Eustachian Tube Dysfunction, which can result in Pressure Equalization (PE) tube placement.

Materials and Methods: In April 2022, our center's rate of PE tube placement was 35%, while the central REDCap HBO registry was 5.0%. Historically, in our center, if a patient had trouble or pain clearing their ears, they were sent to ENT for PE tube placement. Clinicians received additional education on alternative treatment options, and as a result, we changed the practice of how we treat ear problems in our HBO center. If slowing the compression rate and teaching the patient different maneuvers to clear their ears is unsuccessful, the provider would evaluate the patient for nasal or oral decongestants. If these attempts were unsuccessful in relieving ear problems, the patient would be evaluated for PE tubes.

Results: A quantitative data analysis showed that our center treated 63 patients from January 2020 to May 2023, including patients who participated and did not participate in the REDCap HBO registry. Our PE tube placement rate from January 2020 through April 2023 was 37%. Since changing our practice from May 2023 to the present, the tube placement rate has reduced to 21%, for a 16% rate of reduction.

Conclusions: Participating in the HBO REDCap registry allowed our center to evaluate how outcomes and adverse events compare to those of our fellow HBO centers. We recognized that we had a higher incidence of PE tube placement and through implementing an evidence-based practice, including education, the incidents of patients requiring PE tubes were substantially reduced. The International Registered Report Identifier for the registry is RR2-10.2196/18857.

B30

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Thurs, Jun 13, 17:00-17:30
RESIDENT COMPETITION: No

Assessment of prevention of middle ear barotrauma in clinical hyperbaric facilities

Wisniewska I[1], Hall Y[1], Shah JB[1,2]
[1] University of incarnate word School of Osteopathic Medicine; [2] Adjunct Faculty, Associate Professor, UIWSOM, President, Timeoxygen Healing Concepts, LLC, San Antonio, Texas
Presenting Author: Jayesh B. Shah, MD
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Introduction/Background
Hyperbaric Oxygen Therapy (HBO2) is a medical treatment involving the administration of 100% oxygen in a controlled pressurized chamber. UHMS and the FDA have approved the list of Indications. Middle ear barotrauma (MEB) is the most common side effect of HBO2. Different facilities use different standards for ear assessment and barotrauma prevention. There are voluntary physical maneuvers that a medical professional teaches to a compliant and competent patient. These include but are not limited to the Frenzel Maneuver, yawning, mastication, and the Valsalva maneuver. Additionally, the usage of Pseudoephedrine has been shown to keep eustachian tube patent. Appropriate pause of hyperbaric oxygen treatment is essential for proper tympanic membrane healing in case of Upper Respiratory Infection. If HBO2 cannot be paused, a myringotomy must be performed to prevent additional barotrauma. Most barotraumas heal spontaneously if not exposed to hyperoxia, but some barotraumas do not. The ones that do not can lead to further complications such as conductive hearing loss. Myringotomies come with complications such as persistent tympanic membrane perforations, frequent otitis media with effusions, otorrhea, and pain. Improper teaching of Valsalva can potentially cause more harm than good if it is done too forcefully; it can cause round/oval window damage. This study was done through a survey of hyperbaric facilities to review present standards in ear assessment and barotrauma prevention.

Materials and Methods
We sent Survey Monkey surveys about ear assessment and barotrauma to various hyperbaric practitioners via email and social media. We thank Dr. Caroline Fife and UHMS for sending the survey through their email list and social media portals. We received 173 responses in total, but on average, 167 responses consistently answered all the Survey questions.

Results
In this conducted survey from 173 responses. We received the following responses.

- 36% treat emergency HBO indications (24x7), 34% don't treat non-emergency cases, and 30% treat emergencies M – F 8-5.
- 60% treat <150 HBO patients/year, 18% >400.
- 46% have <5 yearly barotrauma cases, 85% <20.
- 71% have <5 needing myringotomy.
- 99% provide patient education.
- 65% teach Valsalva, 15% Frenzel.
- 91% perform pre-HBOT barotrauma risk assessment.
- 8% use tympanogram pre/post HBO.
- 64% check ears pre/post HBO.
- 45% allow non-physicians for ear checks.
- 60% lack competency checks.
- 20% don't treat if URI.
- For URIs: 59% use oral histamine, 53% intranasal steroids, and 48% oral pseudoephedrine.
- 6% use pressure-equalizing plugs, 10% nasal balloon auto-inflation.

Summary/Conclusion
Our study reveals diverse practices for preventing MEB during HBO2. Standardization is crucial for patient safety. Many facilities lack non-physician competency in ear assessment, highlighting a need for development. Auto-inflation techniques, effective in preventing MEB, vary widely in utilization. Pseudoephedrine, effective per a clinical trial but underused, shows a gap between practice and evidence-based medicine.

B31

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Thurs, Jun 13, 17:00-17:30
RESIDENT COMPETITION: Yes

A Physiological Model for DCS Presentations

Strauss MB, Miller SS, Wilson KD
MemorialCare Long Beach Medical Center
Presenting Author: Michael B. Strauss MD
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Introduction
Due to its varied presentations and locations, decompression sickness (DCS) is a syndrome. Scientific work on DCS focuses on more than 20 models for predicting bubble formations using tissue halftimes. Four index cases and awareness of the variability of perfusion provide a physiological explanation for why the signs and symptoms of DCS occur as they do.

Materials & Methods
Four index cases raised questions about the predictability of tissue half times (& even Wienke's free gas phase concept) for explaining these patients' outcomes. Interruption of autoregulation of perfusion coupled with off-gassing gradients provides an explanation.

Results
With over 96,500 Km in line length of our vascular tree, its capacity is, at a minimum, 20 times greater than our 5-liter blood volume. Thus, blood flows where it is needed due to exacting regulation by the sympathetic nervous system & chemical mediators. The index cases: 1) Deaths after precipitous ascent in hard hat gear; 2 & 3) Severe neurological residuals after transient loss of consciousness upon dive completions; and 4) Cardiac arrest on the bottom with intravascular bubbles upon ascent even with CPR led us to generate a 3-compartment model based on physiology rather than tissue half times.

Summary/Conclusions
Transient interruption of perfusion to instantaneously saturated tissues (lungs, blood, heart, and brain-spinal cord) can cause severe neurological residuals from autochthonous bubble formation. A "protected" highly perfusion-regulated group of tissues (muscle, viscera, bone, skin, & subcutaneous tissues) only have perfusion proportional to their activity/metabolic needs and rarely cause symptoms with decompression. Avascular connective tissues (ligaments, tendons, fascia, joint capsules, & membranes) on- and off-gas slowly by diffusion from tissue fluids associated with long or deep dives. Our 3-compartment perfusion-gradient, physiologically-based model explains why DCS presentations appear as they do.

B32

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Thurs, Jun 13, 17:00-17:30
RESIDENT COMPETITION: No

Soft tissue radiation injury and sexual dysfunction; rising curiosity in benefit for HBO2

Sherlock SD
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Presenting Author: Assoc Prof Susannah Sherlock
susannah@wesleyhyperbaric.com.au

Introduction
Soft tissue radiation injury (STRI) is an accepted indication for Hyperbaric Oxygen Treatment (HBO2). The main areas of research have been confined to bladder and bowel injuries. Increasing evidence of efficacy for treating other areas of injury is being published. One area that has a profound impact on the quality of life after survivorship but has not been studied much is sexual dysfunction. Radiation-induced erectile dysfunction is due to hypoxia. We propose to collect incidental data to submit to the Dartmouth Data Registry for all patients referred to us for radiation cystitis who have erectile dysfunction. Patients who have had surgery will be excluded. We plan to do this with The Prince of Wales Hyperbaric unit (another Dartmouth Data registry contributor).

Material & Methods
This is a review of the current evidence for HBO2 in erectile dysfunction after radiation for prostate cancer and vaginal stenosis after irradiation for pelvic irradiation. We propose to collect data to assist in assessing this often not-captured but highly important symptom of STRI. We propose collecting data for proof of concept from patients referred after radiation using the International Index of Erectile Function score (IIEF unmodified). The search terms used were erectile dysfunction and radiation and hyperbaric oxygen in Pubmed, Medline, and Google Scholar. We are proposing to use the data to promote further research.

Results
Few papers have been published in this area, and one randomized controlled trial exists. This proposal is a collaboration of units collecting data and illustrates the powerful use of International Data Registers.

Summary/Conclusions
We propose a collaborative effort to improve knowledge.

B33

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Thurs, Jun 13, 17:00-17:30
RESIDENT COMPETITION: No

Text alert notifications and care process model used to increase hyperbaric consultation rate for carbon monoxide poisoning

Robins MS[1], Weaver LK[2,3]
[1] Intermountain Health, Salt Lake City, Utah; [2] Division of Hyperbaric Medicine Intermountain Medical Center, Murray, Utah, and Intermountain LDS Hospital, Salt Lake City, Utah; [3] University of Utah School of Medicine, Salt Lake City, Utah.
Presenting Author: Marc Robins, DO, MPH
marc.robins@imail.org

Case Description
From 2009-2019, only 35% (±5%) of carbon monoxide (CO) poisoned patients at Emergency Departments (ED) within Intermountain Health (IH) were treated with hyperbaric oxygen (HBO2).

Intervention
To address this lack of appropriate treatment, we implemented a care process module (CPM) with dissemination to all EDs within the region [https://intermountainphysician.org/providers/careprocessmodels under the heading "Pediatric Specialty CPMs and Related Tools."]. The CPM specifies that any patient with CO poisoning requires urgent consultation with a hyperbaric medicine physician. Despite an intensive campaign for awareness of the standard of care presented by the CPM, a three-year prospective review showed no significant difference in the number of CO-poisoned patients treated.

Enlisting the ED informatics team, we developed a text alert system. Abnormally high COHb levels (>5% in non-smokers or >10% in smokers) trigger an automatic text alert to the on-call hyperbaric medicine physician, who then contacts the ED physician to offer a consultation.

Outcome
At this time, available data for the first seven months after the beginning of the alert system shows a 100% capture of all patients diagnosed with CO poisoning in all IH-EDs, and all received hyperbaric medicine consultation (n=91). Of these, 58 (64%) had confirmed poisoning and 48 (53%) received HBO2 treatment. 17 (19%) were smokers with COHb <10%, which inappropriately triggered an alert, but 17 (19%) of the non-smokers were triggered with COHb >5% and required HBO2.

Discussion
Focusing on the lack of appropriate HBO2 treatment for CO poisoning through a quality initiative approach coordinated with interdisciplinary partners resulted in 100% consultation with a hyperbaric medicine physician and an overall increase in the rate of patient treatment with HBO2 from 35% to 53% in a 7-month period.

FRIDAY, JUNE 14
GENERAL SESSION

CHRISTIAN J. LAMBERTSEN, MD, DSc (Hon) MEMORIAL KEYNOTE
(mis)Adventures in the Gulf of Mexico

8 am - 9 am

GUEST SPEAKER: Sean Hardy, MD

About the Lecture:

This lecture will introduce the audience to the unique hyperbaric medicine and diving environment in the Gulf of Mexico through a series of clinical cases highlighting atypical presentations and treatments which have been a part of the LSU Undersea and Hyperbaric Medicine practice over more than 40 years.

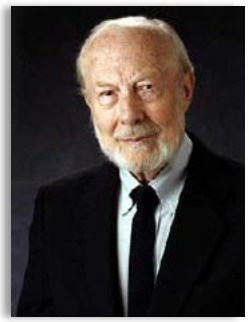
Professional practice gap covered: The overall safety of modern diving and the effectiveness of commonly used tables makes the accumulation of experience in atypical treatments difficult, even for the most dedicated hyperbaric professional. This can lead to a lack of awareness of, and experience using, treatment tables outside of those most commonly utilized in diving medicine. In the rare instances when these treatments fail, familiarity with other treatment options provides hyperbaric physicians with additional opportunities to address diving related illness.

Following this lecture, the audience members will have a broader understanding of hyperbaric treatment options for the treatment of complex, delayed, and refractory decompression illness.

About the Speaker:

Dr. Sean Hardy is a graduate of University of Texas Southwestern Medical School and completed Emergency Medicine residency and Hyperbaric Medicine fellowship at Louisiana State University in New Orleans. He holds academic positions with both Louisiana State University as well as Tulane University in the teaching of medical students, Emergency Medicine residents, and Hyperbaric Medicine fellows. In his 21 years with LSU, he has served in numerous leadership positions including Associate Director of Emergency Services and the Clinical Director of Emergency Preparedness. Dr Hardy has over 25 years in education, with continued emphasis on out of hospital medicine in both civilian and law enforcement/military contexts. Currently, he serves on the National Board of Diving and Hyperbaric Medical Technologists, where he has special emphasis on diver medic education and standards. As part of a remote diving medicine response team, he has been involved in the care of numerous complex diving injury cases and has been a national level lecturer on management of diving injuries and illnesses. In his free time, he continues to be an active diver, martial artist, and sworn tactical medicine provider.

ABOUT CHRISTIAN J. LAMBERTSEN, MD, DSc (Hon)



Dr. Christian J. Lambertsen received a B.S. Degree from Rutgers University in 1938 and a M.D. Degree from the University of Pennsylvania in 1943. During his medical school period, he invented and first used forms of the initial U.S. self-contained closed-circuit oxygen rebreathing apparatus, for neutral buoyancy underwater swimming and diving. As a student, he aided the early Office of Strategic Services (O.S.S.) in establishing the first cadres of U.S. military operational combat swimmers. Dr. Lambertsen became a U.S. Army medical officer on graduation from medical school in early 1943, and immediately joined the O.S.S. Maritime Unit on active duty through its period of function in World War II. He joined the University of Pennsylvania Medical Faculty in 1946 and became Professor of Pharmacology in 1952. While a faculty member he combined diving research and further underwater rebreathing equipment developments for the Army and Navy. In 1967 he served as Founding President of the Undersea Medical Society (now Undersea and Hyperbaric Medical Society.) Dr. Lambertsen is recognized by the Naval Special Warfare community as "The Father of U.S. Combat Swimming." His hand has touched every aspect of military and commercial diving. Dr. Lambertsen's active contributions to diving began during WWII and became even more progressive in the post-war period through the evolutions of the U.S. Navy Deep Submergence and Naval Special Warfare developmental programs.

Principles of isobaric counter diffusion to prevent DCS

9 am – 10 am
Richard Moon, MD
About the Speaker
Dr. Richard Moon earned BSc and MD degrees at McGill University in Montreal, Canada, then trained in internal medicine and biomedical engineering at the University of Toronto. In 1979, he went to Duke to train in pulmonary and critical care medicine. After pulmonary/critical care fellowship he completed training in anesthesiology and in 1983 joined the Duke University faculty. He is Professor of Anesthesiology, Professor of Medicine, and Medical Director of the Duke Center for Hyperbaric Medicine & Environmental Physiology. His research has included the physiology of immersion and predictors of arterial PCO2 during underwater exercise. His work has included the role of patent foramen ovale (PFO) in decompression sickness (DCS). He has been particularly interested in causes and prevention of immersion pulmonary edema, a condition that continues to occur in Navy Special Forces trainees. He has been supported by several Navy grants, recently including use of an experimental breathing gas (perfluoromethane) to decrease decompression requirements after heliox dive. After completing human experiments demonstrating upregulation of mitochondrial biogenesis with low dose carbon monoxide exposure, he is currently studying its effect on training of the respiratory muscles. His work has also included mechanisms of sudden death during triathlons and causes of perioperative opioid-induced respiratory depression, and improved monitoring techniques for monitoring patients to detect it.

Imagineering the Future of Diving

11 am – 11:30 am
Sandra Chapman

About the Speaker:
Program Officer leading Undersea Medicine Program: The goal of this program is to develop improved methods, models, treatments, and devices for understanding, preventing or mitigating factors that negatively impact divers and submariners. Solutions should extend warfighting capability during undersea operations to maximize freedom of action and warfighter dominance.

Commercial diving and DMAC

2 pm – 2:30 pm
Phil Bryson, MBBS

About the Speaker:
Dr. Bryson started off his diving medicine interest at Discovery Bay Hyperbaric Unit in Jamaica whilst he was working in Kingston in the very early days of his medical career. He then moved to Plymouth (UK) where he worked as a volunteer at the Diving Diseases Research Centre for 6 years whilst he completed his training to be a GP.
He then managed to turn his hobby into a career and carried on working at DDRC for the next 25 years being the Medical Director there for his last 11 years, prior to leaving to take up a job at International SOS in December 2010. In 2023 TAC Healthcare took over the Aberdeen International SOS business and he is now their Medical Director of Diving Services.
He has published extensively in specialist medical journals, been the medical advisor to Sport Diving organizations in the UK, sits on the DMAC, EDTC, UK Sport Diving Medical Committee and EUBS committees. He has also sat on several IMCA working groups.

- DMAC is Diving Medical Advisory Committee (advising the Global Diving Industry)
- EDTC is the European Diving Technical Committee
- EUBS is the European Underwater and Baromedical Society
- IMCA is the International Marine Contractors Association

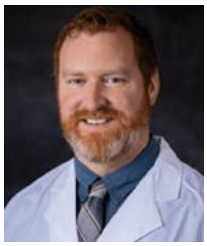
Hard Hat Medicine: The Medical Care of the Compressed Air Tunnel Worker

2:30 pm – 3 pm
Owen J. O'Neill, MD
Professional practice gap covered:
There is not an overwhelming number of practicing undersea and hyperbaric medicine health professionals in the USA. It is probably one of the least medical populated specialties. Many of these professionals are trained with introductory courses in UHM but tend to provide hyperbaric care in the proliferating wound and hyperbaric centers. Less are working in the undersea and commercial diving realm. Those with good skills and experience to care for the working diver or compressed air tunnel worker does not always understand the need for medical care of these workers while performing their duties underground. This lecture hopes to close this knowledge gap and introduce a growing need for this type of medical service and the need for updating the OSHA regulations that govern this type of work.

About the Speaker:
Dr. Owen O'Neill is President and Medical Director of U.S. Hyperbaric Tunnel Medicine and Research Team and the medical director of the Department of Undersea & Hyperbaric Medicine at Phelps Hospital Northwell Health. He has been an active member of the UHMS for many years and currently serves as the co-chairman of the education committee and is a member of the Publications Committee and diving committees. He is the recipient of the UHMS commercial diving award and Excellence if hyperbaric medicine award. He has served various positions on the board of the UHMS and is the current President-elect.

Top articles in Undersea Medicine

4 pm – 4:30 pm
Thomas Gregory, MD: Duke Fellow



About the Speaker:
Dr. Gregory is a second career physician, currently in Undersea and Hyperbaric Medicine fellowship at Duke Health after completing primary specialty training in Emergency Medicine.

Descendancy/Ascendancy of the LSUHSC Hyperbaric Fellowship Program: A history to die for

4:30 pm – 5 pm
Keith Van Meter, MD

About the Speaker:
Keith Van Meter, MD completed his undergraduate education at Miami University at Oxford, Ohio in 1968 with a degree in chemistry and English. He graduated from George Washington University School of Medicine in 1973 with a degree in medicine. He trained at Tulane University School of Medicine/Charity Hospital in New Orleans, Louisiana. He is board certified in Emergency Medicine with subspecialty board certification in Pediatric Emergency Medicine and Diving and Hyperbaric Medicine. From 1989 to the present, Dr. Van Meter has served as the Chief of the Section of Emergency Medicine in the Department of Medicine at LSU Health Sciences Center in New Orleans, Louisiana. He is the Medical Director of a 140-physician Emergency Medicine group in south Louisiana and Mississippi (Keith Van Meter & Associates). He acted as the Medical Director of the Jo Ellen Smith Medical Center Multiplace Hyperbaric Medicine Unit from 1978 until the hospital closed in 1998. He has served as the Medical Director of the Baromedical Research Institute Hyperbaric Laboratory in New Orleans, Louisiana since 1980. Dr. Van Meter served on a task force under Dr. Sam Poole and Dr. Norman McSwain to develop medical support planning for NASA for astronauts aboard a space station from 2000-2002. In his private practice, he has treated over 600 hundred commercial divers in the Gulf of Mexico who suffered from acute decompression sickness or

arterial gas embolism. Dr. Van Meter's primary research interest is the application of hyperbaric oxygen in the ACLS, PALS and ATLS in cardiopulmonary arrest utilizing a swine model.

Session C – Decompression Theory and Mechanisms
ABSTRACTS

C34

ORAL PRESENTATION TIME: Fri, Jun 14, 10:30 - 10:40
POSTER PRESENTATION TIME: Fri, Jun 14, 11:30-12:00
RESIDENT COMPETITION: No

First-in-human imaging of venous gas emboli using a capacitive micromachined transducer toward an underwater wearable ultrasound for personalized decompression

Papadopoulou V[1], Currens JB[1], Biliroglu AO[4], Kemal ER[2], Erdogan EB[2], Eltz K[1], Natoli M[3], Dayton PA[1], Lance R[3], Moon R[3], Oralkan O[2], Yamaner FY[4]
[1] Joint Department of Biomedical Engineering, The University of North Carolina and North Carolina State University, Chapel Hill, NC, USA; [2] Electrical and Computer Engineering, North Carolina State University, Raleigh, NC, USA; [3] Center for Hyperbaric Medicine and Environmental Physiology, Department of Anesthesiology, Duke University School of Medicine, Durham, NC, USA; [4] Clearsens Inc., Raleigh, NC, USA
Presenting Author: Virginie Papadopoulou, PhD
papadopoulou@unc.edu

Introduction/Background
It is well-established that decompression bubbles can cause decompression sickness (DCS), but venous gas emboli (VGE) post-dive suffer from poor sensitivity as predictors of DCS. Conversely, detecting decompression bubbles in real-time as they grow during the dive may offer new insights for real-time control during decompression. Our team has proposed a wearable ultrasound approach implementing multiplexed imaging for concurrent anatomical, VGE (B-mode/Doppler), and microbubble-specific imaging that leverages capacitive micromachined ultrasound transducers (CMUT).

Materials and Methods
A 1D 64-element CMUT array was fabricated and mounted on a 21x21mm2 heat unit board, coated with silicone rubber, packaged in a 3D printed case, and interfaced with a Verasonics programmable ultrasound system for first-in-human testing. Three volunteers completed a dry chamber dive to 132 feet of seawater (fsw) (5 ATA) based on NEDU data. Ultrasound imaging was conducted post-dive using both clinical systems and the CMUT array on the Verasonics, focusing on the heart, subclavian vein, and other peripheral vessels.

Results
VGE were observed post-dive in all three volunteers on four-chamber view transthoracic echocardiography using the VividQ clinical system. VGE were also observed in the subclavian vein using the Mindray clinical system and the prototype CMUT probe on the programmable scanner.

Summary/Conclusion
We demonstrated imaging of VGE using a prototype CMUT array for the first time in humans. Coupled with our previous results demonstrating the reliable operation of CMUTs at depth, these results are highly encouraging for underwater continuous monitoring of decompression bubbles that may provide useful information toward personalized decompression algorithms. Our next experiments in humans will include imaging during the dive.

C35

ORAL PRESENTATION TIME: Fri, Jun 14, 10:40 - 10:50
POSTER PRESENTATION TIME: Fri, Jun 14, 11:30-12:00
RESIDENT COMPETITION: No

Genomic expression patterns in recreational divers with Type 1 decompression sickness prior to hyperbaric oxygen therapy

Cameron BA[1], Zhang J[2], Bouak F[2], Landry D[3], Hillier RL[1a], Harrison DW[4], Khazei A[4], LeDez KM[5], Zbitnew GL[5], Harpur GD[6], Buteau D[7], Smith EM[8], Boland EJ[9], Hicks KG[1]
[1]Experimental Diving and Undersea Group, Canadian Forces Environmental Medicine Establishment, Toronto, Ontario. [1a]Formerly at Experimental Diving and Undersea Group, Canadian Forces Environmental Medicine Establishment, Toronto, Ontario; [2]Defense Research and Development Canada, Toronto Research Centre, Toronto, Ontario; [3]Canadian Forces Environmental Medicine Establishment, Toronto, Ontario; [4]Hyperbaric Unit, Vancouver General Hospital, Vancouver, British Columbia; [5]Eastern Health Hyperbaric Medicine Service, St. John's, Newfoundland; [6]Tobermory Hyperbaric Facility, Tobermory, Ontario; [7]Quebec Diving Medical Centre, Hotel-Dieu de Levis Hospital, Levis, Quebec; [8]Canadian Forces Health Services HQ, Ottawa, Ontario; [9]Joint Logistics Support Group HQ, JFC Brunssum, Brunssum, Netherlands.
Presenting Author: Daniel Landry, MD, CCFP, DRCPSC
daniel.landry1@forces.gc.ca

Introduction/Background
It is likely that delayed HBO2 following DCS onset is accompanied by fluctuating genomic activity and uncertain symptoms. Seeking objective biomarkers for DCS, a recent study using genomic expression methods yielded intriguing results in a relatively small sample size, n=7. The aim of the present study was to add to that data with an increased sample size, recruiting four hospital HBO2 units to opportunistically collect PaxGene blood samples in recreational divers with Type I DCS.

Materials and Methods
PaxGene blood samples were withdrawn from recreational divers with Type I DCS (n=21) prior to HBO2 (PreHBO2) and matched-pair samples (Baseline) at least three months after recovery from DCS. Following RNA extraction, comprehensive bioinformatics workflow applied to RNAseq data (Illumina HiSeq), yielded heat map clustering, differentially expressed genes (DEGs), and enriched gene sets in KEGG pathways and GO terms.

Results
The dive-to-PreHBO2 blood sampling time was tavg=8.4±14.1hrs, a three-fold increase over that in the small study (tavg=2.7±0.5hrs), reporting vastly different results from ours. Our PreHBO2/Baseline comparison yielded 12 up- and 19 down-regulated significant DEGs at PreHBO2, (|FC|>1.5, adjusted p

Summary/Conclusion
The vast differences between patterns of transcriptomic expressions in our study, compared to that in an earlier study, present the possibility of fluctuating genomic activity during immunoinflammatory response in untreated DCS. Consequently, using only one set of "time-sensitive" genomic DCS biomarkers between a dive and testing may not be appropriate. More importantly, longer periods of untreated DCS, for example, due to transport delay or denial, may expand the effects of critical ribo-protein loss to other systems, further confounding the search for DCS genomic biomarkers.

C36

ORAL PRESENTATION TIME: Fri, Jun 14, 10:50 - 11:00
POSTER PRESENTATION TIME: Fri, Jun 14, 11:30-12:00
RESIDENT COMPETITION: No

Decompression stops at three instead of six meters of sea water could reduce the risk of decompression sickness

Plogmark O, Hjelte C, Olsson M, Ekström M, Frånberg O
Blekinge Institute of Technology, Blekinge Tekniska Högskola, 371 79 Karlskrona, Sweden
Presenting Author: Oscar Plogmark,MD
o_plogmark@hotmail.com

Introduction/Background
Longer dives that exceed the limit for direct ascent need decompression stops to prevent decompression sickness. The optimal depths for decompression stops are debated. Two common dive profiles were identified from the Swedish Armed Forces dive table, SWEN21, that were physiologically interesting and comparable.

We aimed to evaluate whether a decompression stop at three meters (1.3 ATA) of seawater is superior to one at six msw (1.6 ATA) in terms of generating intravascular bubbles and whole-body inert gas wash-out volumes.

Materials and Methods
A randomized crossover study with sixteen military divers performing wet dives with a 7-minute-long decompression stop at either six (1.6 ATA) or three msw (1.3 ATA) after 40 minutes at 24 msw (3.4 ATA) was conducted. Intravascular bubbles were graded after the dives using cardiac 2D ultrasound according to the Eftedal-Brubakk scale and were compared between the profiles with the Wilcoxon matched-pairs signed-rank test. Eight subjects also underwent whole-body inert gas wash-out measurements after each dive. The inert gas wash-out volumes were quantified by an exhalate monitor device with sensors for volume, temperature, water vapor, and oxygen. The difference in inert gas wash-out volume between the 6 (1.6 ATA) and 3 (1.3 ATA) msw dives was analyzed using a multilevel linear regression model.

Results
Peak bubble grades were higher for dives with a decompression stop at six (1.6 ATA) msw (median 3, interquartile range, IQR 3-4) than at three (1.3 ATA) msw, (median 3, IQR 2-3), p=0.0049. The whole body wash-out volumes of inert gas were higher for dives with a decompression stop at six (1.6 ATA) msw, 1068 ml (95% Confidence Interval[CI], 962 to 1174) than at three (1.3 ATA) msw, 696 ml (95%CI, 601 to 790), mean difference 373 ml (95% CI, 243 to 502).

Summary/Conclusion
Intravascular bubble measurements and whole-body inert gas wash-out quantification suggest an advantage in performing decompression stops at three (1.3 ATA) msw instead of six (1.6 ATA) msw. This finding could contribute to refining decompression models.

C37

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Fri, Jun 14, 11:30-12:00
RESIDENT COMPETITION: Yes

Physiology of deep Closed-Circuit Rebreather (CCR) mixed gas diving: Gas emboli, spirometry, and biological changes during a week-long liveaboard safari

Balestra C, Lévêque C , Mrakic-Sposta S , Vezzoli A , Wauthy P , Germonpré P, Tillmans F, Guerrero F, Lafère P
Environmental, Occupational, Aging (Integrative) Physiology Laboratory, Haute Ecole Bruxelles-Brabant (HE2B), 1160 Brussels
Presenting Author: Clément Lévêque, PhD
c.leveque.research@gmail.com

Introduction/Background
Actual diving decompression theory hypothesizes inflammatory processes as a source of micro-nuclei, which could increase decompression-related risks.

Materials and Methods
In this study, we tested 10 (44 ± 9 years; 24 ± 4,3 kg/m2) healthy male divers. They performed six to eight dives with a maximum of two dives per day at depths ranging from 21 to 122 msw with CCR mixed gas diving. Post-dive Vascular Gas Emboli (VGE) were counted by echocardiography. Saliva and urine samples were taken before and after each dive to evaluate to evaluate oxy-inflammation: ROS production, lipid peroxidation (ROS, 8-iso-PGF2), DNA damage (8-OH-dG), tumor necrotizing factor-alpha (TNF-, interleukin (IL)-6), and neopterin).

Results
VGE exhibits a progressive reduction followed by an increase ($p<0.0001$), which parallels inflammation responses. Indeed, ROS, 8-iso-PGF2, IL-6, and neopterin increase from 0.19 ± 0.02 to 1.13 ± 0.09 $\mu mol.min^{-1}$ ($p<0.001$); 199.8 ± 55.9 to 632.7 ± 73.3 $ng.mg^{-1}$ creatinine ($p<0.0001$); 2.35 ± 0.54 to 19.5 ± 2.96 $pg.ml^{-1}$ ($p<0.001$); and 93.7 ± 11.2 to 299 ± 25.9 $\mu mol \cdot mol^{-1}$ creatinine ($p=0.005$), respectively. The variation after each dive was held constant at around 158.3 ± 6.9% ($p = 0.021$), 151.4 ± 5.7% ($p <0.0001$), 176.3 ± 11.9% ($p<0.0001$), and 160.1 ± 5.6% ($p<0.001$), respectively.

Summary/Conclusion
When oxy-inflammation reaches a certain level, it exceeds hormetic coping mechanisms allowing second-generation micronuclei as substantiated by an increase of bubble production after an initial continuous decrease consistent with a depletion of the “first generation” pre-existing micronuclei.

C38

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Fri, Jun 14, 11:30-12:00
RESIDENT COMPETITION: No

Decompression gas bubble dynamics in the spinal cord of live rats

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Introduction / Background
Spinal cord decompression sickness (SC-DCS) is caused by the formation of inert gas bubbles in the spinal cord tissue upon decompression. Neurological damage is thought to occur through a combination of ischemic injury, mechanical damage, and complement activation in the vicinity of the bubble, but the exact pathophysiological mechanisms remain unclear. In-vivo experiments have relied on histopathological examinations of bubbles in tissues, but they represent endpoints that do not capture the dynamics of the process. We present a pilot study that directly observes the growth and resolution of decompression bubbles in the spinal cords of live rats with magnetic resonance imaging (MRI) during decompression and recompression treatment.

Materials and Methods
We constructed an MRI-compatible pressure chamber system to visualize gas bubble dynamics in deep tissues in real-time. The system pressurizes and depressurizes rodents inside a 7T MRI scanner to up to 7.1 bar absolute with air while maintaining stable isoflurane anesthesia. Juvenile Sprague-Dawley rats were compressed for 20 minutes, decompressed to 1 bar absolute for 20 minutes, and then recompressed while MR image stacks and vital data were acquired every minute.

Results
Within minutes of decompression, we observed the formation and growth of decompression gas bubbles in the spinal cords of rats. Bubble locations varied; some were associated with spinal veins or formed at the meninges, whereas others formed deep in the nerve tissue. In addition, we observed evidence of hemorrhage in some cases. During recompression, we observed shrinkage and resolution of the bubbles.

Summary / Conclusions
We have demonstrated the direct real-time observation of decompression gas bubble formation, tissue damage, and bubble resolution in the spinal cords of rats using a compression chamber inside an MRI scanner. This gives new access to studying the pathophysiological processes behind SC-DCS.

C39

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Fri, Jun 14, 11:30-12:00
RESIDENT COMPETITION: Yes

Midpoint assessment: A prospective trial on intra- and inter-subject variability in venous gas emboli and other biomarkers after repeated dives

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Introduction/Background
Venous gas emboli (VGE) are widely used as a marker of decompression stress and as a surrogate endpoint for decompression sickness. Recently, a retrospective analysis showed large intra-subject variability of peak VGE grades following identical chamber dives. Here, we present a prospective study investigating intra-subject variability in VGE time series following repeated identical open water dives, coupled with a framework for correlating changes to additional dive conditions, diver characteristics, and biomarker measurements.

Materials and Methods
We aim to have 32 divers complete six identical open-water dives to 100 feet for 30 minutes. Participants complete questionnaires regarding diet, exercise, sleep, and dive history. Dive conditions and profiles are collected with dive computers, and profile consistency is assessed using root-mean-square error analysis under the Bühlmann algorithm framework. Echocardiograms are collected pre-, and every 20 minutes post-dive and analysis consists of Eftedal-Brubakk grading, analyzing peak grade and area under curve (AUC) for each dive. Other measured biomarkers include blood microparticles, vitals, saliva, and urine, which are possible contributing factors to VGE trends. Intra and inter-subject variability in VGE peak and AUC from the 14 divers who completed all six independent dives (n=84) were evaluated using a two-way ANOVA.

Results
107 independent, identical dives were completed by 20 study participants and demonstrated to be typically consistent. The median peak EB grade was 1 (range 0-4), and the average time to peak was 33 minutes (range 22-80). Inter-subject variability accounted for 52.0% and 49.7% in peak and AUC, respectively, with intra-subject variability accounting for only 5.3% and 2.9%, respectively. Salivary uric acid and blood microparticles significantly increased post-dive (both $p<0.01$), and there was no significant change in salivary cortisol ($p=0.68$).

Summary/Conclusion
To date, we have enrolled 20 participants, 14 of whom have completed all six independent dives. Upon completion, this prospective study will provide additional insights on within-diver variability in VGE following repeated dives.

C108

ORAL PRESENTATION TIME: Fri., Jun 14, 10:40-10:50
POSTER PRESENTATION TIME: Fri, Jun 14, 11:30-12:00
RESIDENT COMPETITION: Yes

Innate Immune Cell Responses from Elevated Pressures and Dissolved Gases using Human Lung-on-a-chip Devices

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Introduction/Background
Decompression sickness's (DCS) origins are not fully understood. Previous studies have shown that microparticles (vesicles that shed from immune cells) form due to inert gases under pressure, suggesting a link between dissolved gases and immune cells. While both in vitro and in vivo studies have examined potential immune responses to pressure changes and nucleated bubbles, they fail to account for the role of dissolved gases in a physiologically relevant model.

Materials and Methods
We describe a system to determine immune responses using a custom hyperbaric chamber and human lung-on-a-chip devices. The hyperbaric chamber was designed with a compressor connected to an ASME-code pressure tank equipped to generate pressures up to 7.5 atm, corresponding to dive depths of 67.2 m (220 ft). Human blood samples extracted from healthy donors were infused in two-channel lung-on-a-chip devices, exposed to alveolar gas mixtures, and pressurized to 1.0 atm or 3.5 atm for one hour, followed by decompression at a fixed rate. Phenotypes of neutrophils, dendritic cells, and monocytes were determined by flow cytometry and multiplexed ELISA.

Results
Results indicate a significant immune response occurs at 3.5 atm compared to 1.0 atm controls. From the flow cytometry data, dissolved gases activated several phenotypic markers of innate immune cells (e.g., elevated expressions of CD41a and MPO in neutrophils). The cytokine secretion data showed distinct differences between effects from increased oxygen vs. nitrogen partial pressures, corresponding to compressed alveolar air vs. compressed oxygen-reduced air commonly used in diving (e.g., GM-CSF, IFN- α, and IL-1β).

Summary/Conclusion
This work suggests innate immune reactions may play a role in DCS, which has implications in identifying high-risk individuals and may allow for new means of mitigating DCS. In future work, we will perform epigenetics and transcriptomics on cells in devices to determine the pathways of gene expression that mediate the cellular responses observed.

Grant funded by: Office of Naval Research

Session D – Diving Medicine
ABSTRACTS

D40

ORAL PRESENTATION TIME: Fri, Jun 14, 15:00 - 15:10
POSTER PRESENTATION TIME: n/a
RESIDENT COMPETITION: No

Effect of BHB level and gender on latency to CNSOT

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Introduction/Background
Central Nervous System O2 toxicity (CNSOT) is a potential cause of mortality for working divers. Elevated ketone levels may increase latency to CNSOT based on animal models and have been shown to reduce seizures in refractory epilepsy. Effects of serum beta-hydroxybutyrate (BHB) level and gender-related CNSOT risk are unknown.

Materials and Methods
Male (n=40) and female (n=10) healthy volunteer subjects participated in an investigator-blind, randomized control, crossover study assessing the effects of short-term nutritional ketosis on latency to CNSOT during dives with 100% O2 at 2.06 ATA, head-out immersed divers exercising at 100w. Factors causing dive termination were adjudicated as Definite CNSOT, Probable CNSOT, Not CNSOT, or Finished protocol without CNSOT.

Results
For intention-to-treat analysis (ITT), Pre-Dive BHB(mmol/L±SD) was 0.2±0.1 and 1.8±0.7 for the control(CD) and ketogenic(KD) groups, respectively. CNSOT latency(seconds±SD) was 3589.4±2000.3 and 2389.0±6765.0 for CD and KD groups respectively. Latency to CNSOT by gender for CD and KD dives: Female CD 4140.5±2194.7, Female KD 4281.6±2199.7, Male CD 3433.9±1944.0, Male KD 4123.3±2153.6.

Summary/Conclusion
There was no significant relationship between BHB level or gender and latency to CNSOT. BHB levels were relatively low and inconsistent, possibly not elevated enough to demonstrate a significant difference. For further study, a more reliable means of elevating serum ketone levels, such as pre-dive supplementation, is needed. No significant gender effect was observed.

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D41

ORAL PRESENTATION TIME: Fri, Jun 14, 15:10 - 15:20
POSTER PRESENTATION TIME: n/a
RESIDENT COMPETITION: No

No correlation between increases of spleen volume and changes in circulating pro-inflammatory microparticles following fourteen days of apnea and hypoxia exposures

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Introduction/Background
Breath-hold divers have comparatively large spleen volumes (SpVol). The spleen plays a role in clearing bloodborne microparticles (MPs). Pro-inflammatory MPs are associated with decompression sickness. One potential benefit of a larger SpVol may be enhanced clearance of MPs. Repeated apneas and hypoxia exposure increases SpVol, with the magnitude of adaptation modified by thermal stress. We tested the hypothesis that repeated apnea and hypoxia exposure-induced increases in SpVol are correlated with changes in pro-inflammatory MPs.

Materials and Methods
Thirty healthy adults completed ten maximal apneas and three hours of exposure to normobaric hypoxia (FiO2=0.14) for 14 days within a 16-day period during exposure to cool (CW) head-out water immersion (HOWI) (~28.0°C, n=10, five women), thermoneutral (TN) HOWI (~35.5°C, n=10, six women) or TN air (n=10, five women). On Days 1 and 14, pre-exposure SpVol was measured (ultrasound, Pilström equation), normalized to body surface area, and venous blood was collected for pro-inflammatory MPs analysis via flow cytometry (n=26).

Results
SpVol increased with TN (mean diff. 8 ml/m^2, $p<0.01$) and CW (mean diff. 13 ml/m^2, $p<0.01$) HOWI but not air (mean diff: 3 ml/m^2, $p=0.16$). MPs expressing neutrophil-specific CD66b decreased from Days 1 (248±252 #/µL) to 14 (158±73 #/µL, day effect: $p=0.02$). MPs expressing platelet-specific CD41a did not differ between Days 1 (79±14 #/µL) and 14 (58±10 #/µL, day effect: $p=0.19$). Endothelium-specific CD146 MPs were lower on Day 14 in air (mean diff: -153 #/µL, $p<0.01$) but not TN (mean diff: -11 #/µL, $p=0.76$) or CW (mean diff: 0 #/µL, $p=0.79$) HOWI. Changes in SpVol were not correlated with changes in MPs expressing CD66b+ ($r=0.22$, $p=0.28$), CD146 ($r=0.05$, $p=0.79$), or CD41a ($r=0.21$, $p=0.31$).

Summary/Conclusion
Repeated apnea and hypoxia exposure-induced changes in SpVol were not correlated with pro-inflammatory MPs. Thus, SpVol may not directly impact MP clearance.

Support: Office of Naval Research (N00014-20-1-2593)

D42

ORAL PRESENTATION TIME: Fri, Jun 14, 15:20 - 15:30
POSTER PRESENTATION TIME: Fri, Jun 14, 17:00-17:30
RESIDENT COMPETITION: No

Dive profiles and DCS rate among seafood harvesters in British Columbia Canada

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Introduction/Background
Occupational diving carries a unique risk of Decompression Sickness (DCS). To manage risk, occupational divers in British Columbia are regulated to use the Defence Canada Institute of Environmental Medicine (DCIEM) dive tables. Seafood harvesters have the second highest rate of DCS among occupational divers, exceeded by aquaculture diving. Unlike aquaculture diving, harvesting is conducted in a free-swimming mode where the bottom contours and depth are often unknown, making dive planning more difficult. This study examined the dive profiles to determine the rate of compliance with the mandated dive tables.

Materials and Methods
Twenty-four divers wore ReefNet Sensus dive trackers for one year, monitoring profiles during geoduck, cucumber, red, and green urchin harvesting. A total of 4141 dives were recorded and analyzed for compliance with the tables, ascent rates, and use of safety stops.

Results
Of the 4141 recorded dives, 48% of them fit within the tables. When fitted to the ZHL-16 algorithm commonly used in dive computers with a conservatism set to a gradient factor of 85, this number increased to 98%, suggesting that this sector of occupational divers is using dive computers. Only one diver had profiles that did not fit either the DCIEM tables or a computer model. The rate of DCS incidence is consistent with recreational diving, which also uses dive computers to manage risk, at a rate of 1/10,000 dives.

Summary/Conclusion
Despite the similarity of DCS risk between the harvesters and recreational divers, the harvesters required more treatments. This is likely due to a delay in treatment, either from the remote location of the work or from a lack of recognition of symptoms. The risk of DCS can be reduced if the dive computer is set to a conservative gradient factor to match the DCIEM tables. Diver training in the use of dive computers may also reduce the risk.

D43

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Fri, Jun 14, 17:00-17:30
RESIDENT COMPETITION: No

Metabolic profiling of R.O.C Navy divers under simulated diving training: Implications for health and mission preparedness

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Introduction/Background
Divers often operate in environments characterized by fluctuations in pressure and oxygen concentration. These environmental pressures significantly impact their physical and mental well-being. However, the metabolomic patterns associated with diving training remain unclear. This study aimed to evaluate the effects of simulated diving training on the metabolic patterns of R.O.C. Navy divers.

Materials and Methods
Fifteen healthy male R.O.C. Navy divers participated in the study. Simulated diving training was conducted in a wet chamber facility at the Zuoying branch of Kaohsiung Armed Forces General Hospital, capable of simulating underwater depths of up to 210 feet using Heliox. Urine samples were collected before and after the simulated diving training. These urine samples were analyzed using liquid chromatography–mass spectrometry with the Waters Xevo™TQ-S System.

Results
The study participants had an average age of 32.47 years (±5.2), a mean height of 174.5 cm (±6.2), a mean body weight of 74.27 kg (±7.95), and a body mass index of 24.37 kg/m² (±2.36). Principal Components Analysis (PCA), Partial Least Squares Discriminant Analysis (PLS-DA), and Orthogonal PLS-DA (OPLS-DA) all detected differences in metabolites between pre- and post-diving conditions. In comparison with the pre-diving state, Volcano plot analysis revealed 162 up-regulated metabolites and 130 down-regulated metabolites after diving. The metabolites underwent additional analysis using the Kyoto Encyclopedia of Genes and Genomes (KEGG), revealing significant involvement in pathways such as tryptophan metabolism, purine metabolism, and arginine biosynthesis, closely associated with inflammatory response and oxidative stress. Notable metabolites identified include serotonin, 3-hydroxyanthranilic acid, hypoxanthine, and urea.

Summary/Conclusion
Specific metabolites linked to inflammatory response and oxidative stress following diving have been identified. This study represents the initial comprehensive examination of urine metabolomic alterations following R.O.C. military diving.

D44

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Fri, Jun 14, 17:00-17:30
RESIDENT COMPETITION: Yes

Arterial/Alveolar PO2 ratio in arterial blood gases of SCUBA divers at depth

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Introduction/Background
Current diving physiology postulates that SCUBA divers' arterial blood gas (ABG) levels vary proportionally to environmental pressure, but, to date, ABGs have only been obtained during simulated dives. Also, recent evidence supports the use of the arterial/alveolar (a:A) partial pressures of oxygen (PO2) ratio to predict the arterial PO2 (PaO2) under hyperbaric conditions from measurements obtained at 1 atmosphere absolute (ATA). This work summarizes ABGs obtained for the first time in SCUBA divers underwater and aims to validate the a:A ratio in predicting PaO2 in this subset of individuals at depth.

Materials and Methods
The local ethics committee approved the study. After cannulating the radial artery of the non-dominant limb, ABGs were sampled at the surface before the dive (A), at depth (-15 mfw or -42 mfw, about 2.5 ATA and 5.2 ATA) before (B) and after (C) pedaling on a submersed bicycle for 10 minutes, and back at surface (D). After calculating the surface alveolar PO2 for each subject, the a: A ratio was obtained and used to predict PaO2 at depth. A linear regression between measured and predicted PaO2 was reported, along with the goodness-of-fit F test.

Results
Six subjects performed the dive at -15 mfw, and two others at -42 mfw(respectively about 2.5 ATA and 5.2 ATA). The PaO2 proportionally increased at both depths, remaining stable before and after pedaling. The a:A calculated from the baseline ABG obtained at rest, out of the water, adequately predicted the PaO_2 at depth ($R^2 = 0.96$, $p<0.001$) despite losing accuracy at higher depths.

Summary/Conclusion
The ABGs confirmed the proportional rise of PaO2 in SCUBA divers underwater. The a:A ratio could be used to predict the magnitude of PaO2 rise at depth to limit exposure to hyperoxia, especially in repetitive recreational dives and professional divers.

D45

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Fri, Jun 14, 17:00-17:30
RESIDENT COMPETITION: Yes

Cutaneous decompression sickness in Cozumel

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Introduction/Background
Decompression sickness (DCS) poses a significant challenge in diving medicine, requiring a nuanced understanding of its varied clinical presentations and optimal therapeutic interventions. This study aimed to shed light on the efficacy of ambulatory therapy compared to hyperbaric oxygen therapy in the management of DCS in mild/marginal presentations.

Materials and Methods
A retrospective study was conducted at the hyperbaric medicine service of Costamed Cozumel Hospital, collecting information from DCS patients between November 2019 and November 2023. Patients treated with hyperbaric oxygen and those with mild symptoms treated ambulatorily with normobaric oxygen and intravenous rehydration were evaluated. Accordingly, with the hour hospital protocol, mild presentation consisted of cutaneous manifestations in just one region of the body and no neurological manifestations.

Results
An annual increase in DCS cases treated in hyperbaric medicine was observed. Of the total 289 patients, 78 patients received ambulatory treatment for mild symptoms, while 211 required hyperbaric oxygen for moderate or severe symptoms. From the group with moderate or severe symptoms 51 patients also had cutaneous symptoms. Recurrence after ambulatory treatment was present in four patients who were later treated with hyperbaric oxygen.

Summary/Conclusion
Ambulatory treatment with oxygen and intravenous rehydration proved effective for mild symptoms, with minimal recurrences. Hyperbaric therapy seems necessary only in cases of moderate and severe symptoms. The evaluation of ambulatory therapy in comparison to hyperbaric oxygen therapy for decompression sickness yields valuable insights into optimizing treatment strategies. This study contributes to the evolving landscape of diving medicine, emphasizing the importance of individualized care in managing the diverse clinical presentations of DCS. It is essential to conduct a proper assessment of signs and symptoms in DCS patients with marginal symptoms and offer the alternative of ambulatory treatment.

D46

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Fri, Jun 14, 17:00-17:30
RESIDENT COMPETITION: No

Thermal perceptions and thermoeffector responses during a progressive cold-water challenge

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Introduction/Background
Thermal comfort and thermal sensation strongly influence behavioral thermoregulation to avoid the activation of thermoeffectors such as shivering during cold exposure. Avoidance of shivering during cold underwater diving is important to maintain muscle control and motor function. It is not known whether changes in thermal perceptions precede changes in thermoeffectors during a progressive cold-water challenge. We tested the hypothesis that changes in thermal perception during cold exposure occur at warmer water temperatures versus changes in thermoeffectors (i.e., oxygen consumption and shivering).

Materials and Methods
Ten healthy young adult participants (body mass index: 26±6 kg/m^2) completed one progressive cold-water challenge. Thermal perceptions (thermal discomfort (1=comfortable; 4=very uncomfortable) and thermal sensation (1=cold, 4=neutral, 7=hot)), shivering (Bedside Shivering Scale (0=no shivering, 3=severe shivering) and oxygen consumption (VO2) measurements were obtained while participants sat upright in a dry water immersion tank. Then, 35°C water rapidly filled the tank to the level of the mid-sternum. Water temperature was lowered by 5°C every 30 minutes until it reached 10°C, after which it was maintained at 10°C for up to a total of 240 minutes of immersion time. Data were collected every 5 minutes during immersion. The cold-water challenge was terminated if the rectal temperature fell below 35.5C or if participants were asked to terminate the immersion. Segmental analysis was used to determine the water temperature when perceptual responses, VO2, and shivering values abruptly changed during the immersion (i.e., breakpoint). Values are mean±SD.

Results
The water immersion time was 143.0±55.4 minutes, and the final water temperature was 14.2±3.9°C. The breakpoint water temperatures for thermal discomfort (20.3±4.5°C), thermal sensation (22.7±4.9°C), VO2 (21.3±4.4°C), and shivering (21.9±2.6°C) were not different from each other (P = 0.469).

Summary/Conclusion
Abrupt changes in thermal perceptions and thermoeffectors occur at similar water temperatures during a progressive cold-water immersion challenge.

Support: Office of Naval Research (N00014-21-1-2276)

D47

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Fri, Jun 14, 17:00-17:30
RESIDENT COMPETITION: Yes

Long-term cardiovascular health in divers: A registry-based study on the use of antihypertensive medication among professional divers in Norway

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Introduction/Background
Professional divers operate under demanding physiological conditions, experiencing immediate cardiovascular effects such as blood centralization due to immersion, which impacts preload and afterload. However, understanding long-term cardiovascular implications, potentially leading to the need for antihypertensive medication, remains limited. We aimed to explore the use of antihypertensive medications as a marker for cardiovascular disease among professional divers.

Materials and Methods
The study population comprised professional divers who held occupational diving certificates (I, II, or III) in Norway between 1980 and 2011 (n=3,699). The control group comprised a sample from the general population (n=10,978) matched on month/year of birth and gender. The Norwegian Prescription database provided data regarding the use of medication for hypertension during the period from 2009 to 2020. The possible impact of diving exposure on the need for antihypertensive medication was analyzed in a negative binomial regression model with adjustment for possible confounding factors.

Results
The mean age at the end of 2020 was 58.4 years (SD 11.2). The control group was significantly more likely to start antihypertensive medications than the professional divers (Incidence rate ratio 1.13, CI: 1.07 to 1.19).

Summary/Conclusion
Our findings indicate a lower rate of antihypertensive medication use among professional divers compared to the general population. However, these results should be interpreted considering the healthy worker effect among divers. While the control group is gender and age-matched, it offers a broader range of subjects, providing greater cohort diversity. Our study is observational; causality, therefore, cannot be established. The use of antihypertensive medication indirectly suggests hypertension.

D48

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Fri, Jun 14, 17:00-17:30
RESIDENT COMPETITION: Yes

Selection of pre-dive ketone regimen to evaluate impact of short-term ketosis on latency to CNS O2 toxicity in working divers (KETOX 2)

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Introduction/Background
Short-term nutritional ketosis may be associated with prolonged latency to central nervous system oxygen toxicity (CNSOT). Ketone food product administration may raise ketone levels more quickly and predictably than dietary modification, supporting a regimen to be tested for CNSOT mitigation.

Materials and Methods
16.2g beta-hydroxybutyrate (BHB) ketone salts, 10g medium chain triglyceride (MCT) oil powder, and increasing regimens (6-33g) of 1,3-butanediol acetoacetate diester (KDE) were given to the first 15 healthy volunteers and side effects were documented. Weight-based response was noted, and 0.5g/kg and 0.6g/kg regimens of the KDE were additionally evaluated. Point-of-care BHB and Acetone, plus UPLC-MS/MS BHB and acetoacetate (AcAc) levels, were assessed for 6 hours post-ingestion. Side effects and pre/post-study blood counts, metabolic panels, and urine were analyzed.

Results
Nineteen subjects (mean±SD: age 25.8±5.6 years, BMI 24.1±2.2) completed the evaluation. Total serum AcAc and BHB AUC increased in a stepwise fashion with increasing regimens (Multiple R=0.86; $p<0.001$). Peak total serum AcAc and BHB levels rose significantly with increases in dose (Multiple R=0.80; $p<0.001$). No clinically significant changes in blood, metabolic, or urine studies were observed. Self-limited adverse effects included hunger (73.7%), fatigue (31.6%), headache (31.6%), stomach pain (26.3%), nausea (15.8%), and diarrhea <1 hour after trial (5.3%). One participant at the highest 0.6g/kg regimen had diarrhea during the trial and required treatment for moderate nausea.

Summary/Conclusion
Serum ketones were elevated in a weight-based fashion and maintained long enough to perform a dive. No mission-limiting side effects were observed at/below 0.5g/kg KDE over six hours, and no significant electrolyte or metabolic abnormalities were observed. A regimen of 16.2g BHB salts, 10g MCT oil powder, and 0.5g/kg KDE is hypothesized to delay CNSOT and was selected to compare against placebo in a randomized, double-blind, crossover trial of in-water, exercising divers at 2.06 ATA breathing 100% O2.

Acknowledgments
NAVSEA Contract N00024-22-C-4323

D49

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Fri, Jun 14, 17:00-17:30
RESIDENT COMPETITION: Yes

New methods for head-out water immersion in freely behaving rats to study CNS oxygen toxicity

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Presenting Author: Courtney Wheelock, PHD
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Introduction/Background
Current murine research models do not allow examination of central nervous system oxygen toxicity (CNS-OT) induced by exposure to hyperbaric oxygen (HBO2) during immersion. We aim to develop a novel model for head-out water immersion (HOWI) in freely behaving rats during hypercapnic HBO2.

Materials and Methods
A rodent diving pool was manufactured with plexiglass, surrounded by an aluminum tank embedded with runs of copper coils perfused with temperature-regulated water, and set in a larger exposure chamber. The grated pool cover allows equilibrium with the exposure chamber, which is ventilated with either air or mixed gas (97.5% O2 bal. CO2). The exposure chamber fits inside a hyperbaric chamber, which is pressurized in parallel using air.

Inlets and outlets for water supplying the pool and air supplying the exposure chamber are connected with high-pressure flexible PVC tubing. These pass through the hyperbaric chamber to a circulating water bath or appropriate gas mixture. A gas analyzer monitored fractional O2 and CO2 inside the exposure chamber. The pool is fitted with a rapid dump value to quickly lower the water level under pressure at CNS-OT onset.

To test this model, six Sprague-Dawley rats (250-300g) were familiarized (3 weeks; 2x/day) to thermoneutral water (~34°C). Water level and immersion time gradually increased during each session. After training, rats were exposed to hypercapnic HBO2 at 3ATA in dry or HOWI conditions, latency to seizure (LSz) was recorded.

Results
Test dives confirmed similar dive profiles during dry and wet HBO2. LSz was 30.5±10.9 min during dry exposures and 11.6±4.0 min during HOWI ($p=0.04$; $n=4$). Length of water immersion was 37.0±9.5 min.

Summary/Conclusion
Initial results confirm observations in human studies that water immersion decreases LSz during HBO2. This model is an important contribution to the undersea field aiming to accurately simulate Navy diving conditions.

Funding provided in part by ONR grant N000142312717 and NIH-T32 grant T32HL160529

D50

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Fri, Jun 14, 17:00-17:30
RESIDENT COMPETITION: No

Blood gas parameters from conventional and ketogenic diet dives

Derrick BJ, Allen CM, Ellis MC, Makowski M, Gonzalez S, Natoli M, Richardson C, Sayers MP, Winstead-Derlega C, Keuski B, Moon RE, Freiberger JJ
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Central Nervous System O_2 toxicity (CNSOT) continues to risk Navy diving operations by impairing mission performance and diver safety. Nutritional ketosis (NK) has been shown to increase latency to CNSOT seizures in animal models and can be effective in managing refractory pediatric epilepsy. Effects of NK on arterial and venous blood gas (ABG/VBG) values like pH, PaCO2, electrolytes, and lactate values are unknown. PaCO2 likely affects cerebral blood flow and possibly the onset of CNSOT.

Materials and Methods
ABG or VBG was collected before, during, and after dives (100% O2 at 2.06 ATA (35 fsw), immersed in water to shoulders while exercising) completed after a randomized control (CD) or ketogenic (KD) diet. ABG was performed if the subject had no contraindications and consented; otherwise, VBG was assessed.

Results
Samples collected: 120 CD ABG, 168 KD ABG, 174 CD VBG, 129 KD VBG. Mean±SD dive Time(min), ABG pH, PaCO2(mmHg) and lactate(mmol/L) for CD and KD dives were 73.8±36.7/7.38±0.20/40.9±8.9/1.3±0.5 and 73.1±36.4/7.38±0.18/41.9±9.1/1.3±0.4 respectively. Mean±SD dive Time(min), VBG pH, PaCO2(mmHg) and lactate(mmol/L) for CD and KD dives were 77.6±39.1/7.37±0.20/43.7±9.3/1.3±0.4 and 77.0±39.17.37±0.20/43.7±9.3/1.3±0.4 respectively.

Summary/Conclusion
There was a trend toward increased latency to CNSOT after NK vs CD dives (previously reported). Short-term ketosis did not appear to alter pH or PaCO2. While pH and PaCO2 may play a role in modulating cerebral blood flow and risk for CNSOT, we did not observe a difference between control and ketogenic groups in this study related to CNSOT latency or ABG/VBG values. Risk/benefit analysis was not in favor of arterial sampling over venous sampling in this study.

Funded by: NAVSEA Contract #N0002418C4315, ONR Grant #N0002418C4315

D51

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Fri, Jun 14, 17:00-17:30
RESIDENT COMPETITION: Yes

Integrated diaphragmatic function, chemosensitivity, and endurance in exercising divers

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Introduction/Background
The divers experience increased ventilatory load, which can lead to respiratory muscle fatigue and hypercapnia. Hypercapnic ventilatory response (HCVR) is a highly variable measure of the physiological response to increased pCO2, and a lower HCVR is associated with increased pCO2 while diving. Respiratory muscle training (RMT), which has been shown to augment endurance in divers, is also associated with increased HCVR in those with a low baseline HCVR. A prior study in our lab showed that sub-toxic CO exposure has beneficial effects on skeletal muscle. This study aimed to test the effects of RMT (with and without CO) on chemosensitivity (HCVR), integrated diaphragmatic function (IDF), and diving exercise endurance.

Materials and Methods
Fit male and female subjects (VO2peak > 35 $mL*kg^{-1}*min^{-1}$ and 30 35 $mL*kg^{-1}*min^{-1}$ respectively) were recruited. Baseline spirometry, HCVR, VO2peak (dry and wet), and submersed (55 fsw) exercise endurance at 85% VO2peak with intermittent arterial blood and pyruvate samples, IDF, and transdiaphragmatic pressure were assessed. Subjects then completed twenty 30-minute RMT sessions over one month with either air or 200ppm CO (double-blinded). Blood samples have been analyzed for stopped-flow analysis of O2 offloading from hemoglobin (Hb).

Results
Currently, 43 subjects have enrolled, with 24 having completed all phases. Preliminary results show RMT increasing respiratory muscle static pressures, HCVR for those with low baselines, and endurance duration. Post-RMT subjects have also shown higher mean arterial pCO2 while exercising and decreased ventilation. Preliminary data support significant differences in human vs. murine erythrocyte oxygen kinetics.

Summary/Conclusion
As predicted, RMT has a beneficial effect on divers and improved chemosensitivity, integrated diaphragmatic function, and exercise endurance at depth. However, mean pCO2 and ventilation significantly decreased following RMT. Overall, RMT seems to improve underwater endurance performance through changes to chemosensitivity, IDF, and skeletal muscle enhancement. Since the study is still blinded, the effect of CO is pending.

D52

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Fri, Jun 14, 17:00-17:30
RESIDENT COMPETITION: Yes

Increased fat oxidation after combat diver training

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Presenting Author: Clara Sjöblom MSc
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Introduction/Background
Fat oxidation and concomitant oxygen consumption can be increased by hyperoxia during submaximal work. Combat diver (CD) training is physically demanding and includes underwater swimming with high partial pressures of oxygen and fat oxidation rates, which may affect divers' endurance performance, dietary needs, and gas consumption. The effects of recurring hyperoxic exposure on fat oxidation are still unclear, and research on fat utilization among divers is limited. The aim of this study was to investigate fat oxidation rates in relation to CD training.

Materials and Methods
Maximal fat oxidation (MFO) was studied in male CD in normoxia before and after 16 weeks of CD training distributed over nine months and compared with a control group of amphibious rangers without diver training. MFO was measured by indirect calorimetry in a fasted state with an incrementing cycle test and was defined as the highest mean value of fat oxidation. Mean differences in MFO between before and after CD training were compared between CD and controls with independent t-test and within groups with dependent t-test.

Results
Five CDs (age 23.6±2.7 years, BMI 26.2±standard deviation]) and seven controls (age 23.0±2.7 years, BMI 26.2±1.6) completed the study. MFO at baseline was in CD 0.44±0.09 g/min and in controls 0.48±0.14 g/min. MFO increased in CD to 0.58±0.06 g/min (95% CI 0.04 to 0.24), while no difference was found in controls at 0.48±0.11 g/min (95% CI -0.14 to 0.14). The between-group difference in change from baseline was 0.14 g/min (95% CI -0.01 to 0.29).

Summary/Conclusion
We observed increased MFO after CD training; the difference was, however, not significant compared to controls. Several factors of CD training may influence fat oxidation, including hyperbaric hyperoxia from diving and a level of negative energy balance.

D53

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Fri, Jun 14, 17:00-17:30
RESIDENT COMPETITION: No

Recovery from pulmonary oxygen toxicity: A new (ESOT) model

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Introduction/Background
Hyperoxic exposure may cause pulmonary oxygen toxicity (POT), measurable as a reduction in Vital Capacity (VC). Arieli has, in a series of works, demonstrated that a new metric (Arieli K) would better predict POT development and recovery than the traditional UPTD/OTU. We have previously shown that Arieli K is computationally intensive for multi-pO2 segmented exposures. For this reason, we developed the ESOT (Equivalent Surface oxygen Time) metric. We have pointed out that the Arieli K recovery model will predict a counterintuitive development of POT after repetitive and multiday exposures because recovery kinetics is controlled by the exposure pO2. The objective of this work was to investigate whether another model would better predict POT recovery.

Materials and Methods
We investigated whether a recovery model controlled by exposure time (texp) would better predict POT recovery after continuous or intermittent hyperoxic exposures. We tested the equation ESOTrec=ESOTi*exp(-r*t*s^texp). (ESOTi: Pre-recovery POT metric after hyperoxic exposure time texp (h), ESOTrec: ESOT after recovery time t (h), r and s constants). Data from previous studies on recovery after hyperoxic exposures allowed fitting of constants while cross-validation and bootstrapping allowed validation. Results were compared to Arieli K by means of Root Mean Squared Error (RMSE) and the corrected Akaike Information Criterion (AICc).

Results
The optimal fit was reached by r=0.439 and s=0.906. RMSE ranged from 1.4-2.7 % of predicted VC change similar to or slightly better than Arieli K. The similar fit to observed changes and less model complexity caused Arieli K to exceed the ESOT recovery function by 8.4 AICc units, demonstrating the relative superiority of the proposed ESOT model. Development of POT during intermittent hyperoxic exposures can be predicted better by ESOT than Arieli K.

Summary/Conclusion
ESOT will better predict VC recovery after hyperoxic exposures than Arieli K.

D54

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Fri, Jun 14, 17:00-17:30
RESIDENT COMPETITION: Yes

Efficacy of hyperbaric oxygen therapy in cases of decompression sickness with delay to evaluation

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Introduction/Background
Despite the evaluation and treatment of decompression sickness (DCS) being a core component of Undersea and Hyperbaric Medicine (UHM), there is limited literature or guidance on the efficacy of Hyperbaric Oxygen Therapy (HBO2) in cases presenting beyond 24 hours from symptom onset. Less still exists for greater than one week, and consensus on when to offer treatment varies among UHM providers. Assessment of "delayed DCS" cases may lead to more consistent clinical practice and improved resource utilization. This study reviewed cases of DCS, with data gathered on timelines from DCS symptom onset to evaluation, treatment decisions, and patient outcomes.

Materials and Methods
As a quality improvement (QI) initiative, cases of DCS were identified at a single institution from 2013 to 2024. Cases presenting >24 hours after symptom onset were reviewed to determine the time to evaluation, treatment, and outcome. Cases were grouped by timeline (24-48 hours, 48-96 hours, 96 hours—seven days, one to two weeks, two to three weeks, > 3 weeks).

Results
Of 108 cases of DCS, a total of 34 presented >24 hours after symptom onset. Findings are summarized in Table 1.

Table 1

Delay	Cases	Treated	Improved
24-48h	12	11	10/11 (90.9%)
48-96h	5	5	4/5 (80.0%)
96h-7d	11	9	9/9 (100%)
2-3w	1	1	1/1 (100%)
>3w	5	3	2/3 (66.6%)
All >24h	34	29	26/29 (89.7%)

Of DCS cases treated greater than 24 hours from symptom onset, 89.7% had improvement with HBO2. Of the three without demonstrated efficacy, one was five weeks from onset, two had presentations more consistent with pathology other than DCS.

Summary/Conclusion
Experience and accumulated case data from this single institution appear to support treatment of delayed DCS cases, even weeks after symptom onset. Overall, of DCS cases treated greater than 24 hours from symptom onset, 26 of 29 patients (89.7%) had improvement with HBO2, despite even significant delay.

D55

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Fri, Jun 14, 17:00-17:30
RESIDENT COMPETITION: No

Vital Signs Monitoring of Compressed Air Workers during Hyperbaric Interventions in TBM

Subbotina N[1], Castro J[2], Pellegrini L[2], Frydman JD[3], Correa L[3]
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Presenting Author: Nina Subbotina MD, PhD, Professor of medicine
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Introduction/Background
Since work in compressed air inside tunnels is gaining eminence, it is required to investigate the effects of the dry hyperbaric environment on workers' health, especially in countries without statutory limits on hyperbaric exposure.

Materials and Methods
24 workers were carrying out mechanic maintenance of the cutterhead of the Mixshield TBM in a hyperbaric environment. 186 reports were obtained from 236 observations collected during 69 interventions. Working pressure ranged from 0.9 bar gauge to 3.6 bar gauge; the bottom time varied between 0:30 and 7:45 hours. Vital signs (BP, HR), and cognitive and psychological assessment were carried out prior to and after the intervention. Stroke volume and cardiac output were calculated based on vital signs and body surface area.

Results
Vital signs after the surfacing showed statistically significant changes. BP was slightly reduced, and HR increased, keeping all parameters within normal limits; cognitively and psychologically, the workers stayed positive. The variation in vital signs statistically confirmed in all records was analyzed in detail, focusing on the working pressure, forming four groups, as shown in the table below. Surprisingly, when the workers were exposed to higher pressure, minimal variation of vital signs was observed.

Change of Vital Signs	0,9 – 1 bar (52 records)	1,1 – 2,3 bar (38)	2,4 – 2,5 bar (74)	2,6 – 3,6 bar (41)
SBP mm Hg	-10.50	-2.38	0.20	-0.42
DBP mm Hg	-4.89	-2.75	-1.03	-1.91
HR	6.56	4.00	2.40	1.51

The bottom time and total duration of the intervention haven't shown any relationship with the observed VS changes.

Summary/Conclusion
The interpretation of vital signs' changes is challenging. Which of the environmental or labor factors combination inside the TBM - high air density, relatively hyperoxia, supposed nitrogen narcosis, high temperature and humidity, physical and psychological stress accompanied by pressure changes - produced observed phenomena is hypothesized.

D56

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Fri, Jun 14, 17:00-17:30
RESIDENT COMPETITION: No

Volatile organic compounds in cellular headspace after hyperbaric oxygen exposure; An in *vitro* pilot study

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Introduction/Background
Pulmonary Oxygen Toxicity (POT) is a tracheobronchial condition that arises from prolonged exposure to an elevated partial pressure of oxygen, causing permanent alveolar damage with extended exposure. Divers utilizing hyperoxic gas blends, and particularly special operations forces engaging in long-range missions with 100% oxygen rebreathers, face the risk of developing POT. Despite multiple studies attempting to identify definitive biomarkers for POT by measuring Volatile Organic Compounds (VOCs) during regular diving activities and exposure to treatment tables, none have been conclusively identified. The ethical concerns surrounding the need for more extreme exposures in human studies prompted the introduction of an in vitro model in the present study. This model is designed to detect VOCs associated with oxidative stress, offering a potential alternative to human studies.

Materials and Methods
Human alveolar basal epithelial cells were exposed to the pressure profile of a US Navy treatment table 6. The headspace of the intervention group consisted of 100% oxygen, with a control group exposed to (compressed) air. During and after pressurization, VOCs in the headspace were captured and analyzed using gas chromatography-mass spectrometry. Interleukin-8 (IL8) and lactate dehydrogenase (LDH) levels in the cell supernatant were measured to assess cell stress.

Results
Three VOCs—nonane ($p = 0.005$), octanal ($p = 0.009$), and decane ($p = 0.018$)— varied significantly between the hyperoxygenated intervention and control groups. IL8 and LDH levels also differed, indicating elevated cell stress in the intervention group.

Summary/Conclusion
As seen in previous studies, the expression of identified compounds was lower in the intervention group, still challenging conventional understanding. Despite its limitations, the simplified in vitro model showed promise, with two of the three identified VOCs also found in a prior study with navy divers after similar hyperbaric exposure. The decrease in VOC expression calls for further investigation into the dynamics of oxidative stress.

D57

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Fri, Jun 14, 17:00-17:30
RESIDENT COMPETITION: No

Impairment of cognitive task performance during simulated 10 m dive

Fujii T
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Introduction/Background
Various factors constrain human cognitive performance during underwater operations. Inert gas narcosis is one serious problem when divers breathe compressed air deeper than 30 m, but previous studies reported impaired cognitive performance even at shallower depths (e.g., 5 to 20 meters). This study was conducted to confirm the effects of breathing compressed air at relatively shallow depths on cognitive performance.

Materials and Methods
Thirty-five male divers participated in this study (34.03, SD = 7.67). All participants graduated from a diving course in Japan Maritime Self-Defense Force and have expertise in diving. Participants performed paper-and-pencil mental rotation tasks in the laboratory and diving pool connected below the hyperbaric chamber. The hyperbaric chamber and diving pool were compressed for equivalent to ten meters depth. Participants breathed compressed air supplied by a surface-supplied diving system. The mental rotation task consisted of 32 pairs of 3-D objects that differed by 45 to 180 degrees in picture plane each other. Participants were instructed to judge whether the two paired 3-D objects were the same or different. Eighteen divers performed the task for the first time in the laboratory, and other dives were performed for the first time at the diving pool. Divers' performance was measured by the number of incorrect answers and task completion time.

Results
The number of incorrect answers was increased in the diving pool compared with the laboratory (Laboratory = 5.40, diving pool = 8.66, $p < .01$). Task completion time was not different between experimental fields (Laboratory = 245.54 seconds, diving pool = 270.09 seconds, *nanoseconds.*).

Summary/Conclusion
Diving with compressed air causes deterioration of cognitive function even at 10 meters.

D59

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Fri, Jun 14, 17:00-17:30
RESIDENT COMPETITION: No

A Retrospective review of diving accidents treated in Puerto Rico from 1997 to 2018

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Presenting Author: Richard Fontanez-Aldea, Jack Meintjes, Pedro Arroyo-Ramirez
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Introduction/Background
Artisanal fishermen's diving behavior is directed towards harvesting high-value species for sale. Economic pressures commonly result in an inadequate risk perception. The risk for decompression illness in the artisanal fishing community is extremely high compared with that of other divers. There is a paucity of research regarding the treatment of decompression sickness in artisanal fishermen in Puerto Rico.

Materials and Methods
A cross-sectional study will be performed to describe the study population. A nested case-control study will be performed to evaluate factors associated with complete and incomplete healing following recompression therapy. Puerto Rico Island is an American territory located in the Caribbean Basin. The Hyperbaric Medicine Center (HMC) is part of the public health system, and it is the only service available for the treatment of diving accidents on the island since its founding in 1997.

Results
964 DCI evaluated • In order to maximize the potential impact of the study, the researchers aim to include all of the cases treated over the study period (1997 to 2018). No sample will be taken for this study. Approximately one thousand cases are expected to be available for analysis over the study period.

Summary/Conclusion
The study is directed to raise awareness of the high number of diving accidents in the fisherman-diver population of Puerto Rico, which is part of the United States. Because of the paucity of information on this group of divers, this study will aim to describe the diving accidents treated in Puerto Rico over a period of 21 years. study will also aim to find factors that are associated with a poor outcome, such as delay to treatment, severity of the disease, age of the diver, use of illegal drugs, previous decompression sickness history, diving profile, etc.

SATURDAY, JUNE 15
GENERAL SESSION

Jefferson C. Davis Memorial Keynote
Non-compliant chambers: Individual liability, and a threat to our industry

8 am – 9 am

GUEST SPEAKER: Francois Burman, Pr Eng, BSc (Eng), MSc

About the Lecture:

The sale and ultimately use of non-compliant chambers has become a world-wide issue. Few physicians and program directors understand their vulnerability to legal sanction, as well as the potential harm to staff, patients, and the public, when using equipment that does not comply with safety standards. While the regulation of pressure vessels for human occupancy is well described in terms of published documents, there are many ways that non-compliant chambers enter into medical practice. The ultimate responsibility for safety usually rests with attending physicians, program managers or owners. Our codes and standards have generally been developed based on a need to protect our people, as well as our industry. Inappropriate medical practices aside, our equipment must be safe for use regardless.

Professional practice gap covered:

Compliance with codes and standards governing design, manufacturer, testing, and certification is the responsibility of producers and sellers of hyperbaric chambers. However, an informed understanding of what is or is not compliant is perhaps difficult to grasp for end-users. As the responsibility for people and property cannot be separated from the responsibilities of medical service providers, it is imperative that they are able to make informed decisions as to the safety of their facilities, including the hyperbaric chamber.

The practice of medicine requires specialized training and experience in a very specific field, which in general excludes the detailed engineering that goes into establishing a hyperbaric operating unit. A basic understanding of what chambers are required to comply with will assist in making appropriate and safe decisions during both procurement and commissioning activities. This applies to new, used, and repurposed hyperbaric chambers.

About the Speaker:

Francois Burman BSc (Engineering), International PE, MSc (Medical Sciences) is the Director of Risk Mitigation at Divers Alert Network. He is primarily responsible for all safety and accident prevention initiatives, aimed at making diving safer. The recompression chamber network is also his responsibility, and he has travel across the world doing safety assessments at facilities used to treat injured divers. He has written a series of books and papers specifically aimed at the hyperbaric and diving industry, and regularly presents lectures on safety in this field. Francois serves on a range of hyperbaric industry committees, including the UHMS Safety Committee and ISO, ASME-PVHO and NFPA standards committees.

JEFFERSON C. DAVIS, MD KEYNOTE LECTURE

About Dr. Davis:

Dr. Jefferson C. Davis devoted his entire adult life serving the diving, aerospace and hyperbaric communities. Through his clinical practice, educational activities, and publications, he inspired several generations of clinicians to provide quality medical service for divers, aviators, and hyperbaric medicine & wound care patients.

Dr. Davis was born December 7, 1932, and raised in Neosho, Missouri. After receiving his MD at the University of Missouri in 1958, he joined the US Air Force Medical Corps to become a flight surgeon. He received his MPH from the University of California at Berkeley and was board certified in Aerospace Medicine. He studied diving medicine at the US Navy Experimental Diving Unit in Washington DC. In 1965, Dr. Davis and his colleagues created the first US Air Force course in Hyperbaric Medicine. He founded "LEOFAST," the US Air Force predecessor of Divers Alert Network. In 1974 he founded and became the first Director of the USAF Hyperbaric Medicine Center at Brooks Air Force Base Texas, which now bears his name. He created the Davis Protocol in the application of Hyperbaric Medicine for wound healing enhancement. He became Medical Director for Medical Seminars' Medicine of Diving Program in which physicians from all medical specialties could learn to treat injured divers and to serve as consults to their local diving communities. In 1979, after 20 years of service Dr. Davis retired from the US Air Force as a Chief Flight Surgeon in the grade of Colonel. Dr. Davis became founding member and president of International ATMO, Inc. the first know contract provider of wound care and hyperbaric medicine services. He set up a successful practice at two San Antonio hospitals.

His compassion for his patient's well-being was legendary and he contributed much to the diving, aerospace and hyperbaric medicine communities.

Randomized controlled blinded trial design & conduct: Challenges-pitfalls-solutions

9 am – 10 am
Dick Clarke, CHT-Admin

About the Lecture:
Much of the practice of hyperbaric medicine lacks supportive high-quality efficacy and even compelling effectiveness evidence. Treatment decisions are based on various combinations of basic science research, other pre-clinical data, some prospective but mainly retrospective case reporting (invariably uncontrolled), textbook chapters, meeting Abstracts, and the essential matching of disease pathophysiology with one or more hyperbaric mechanisms, arguing biological plausibility. Except for one historic close call involving Blue Cross Blue Shield, the practice of hyperbaric medicine within the United States continues to skirt evidence-based medicine's increasingly focused microscope.

Professional practice gap covered:

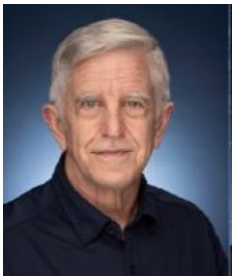
There is a distinct need to improve underlying clinical science in support of the practice of hyperbaric medicine through development of high-quality clinical trials. Learners will become familiar with how such trials are designed, conducted, and reported, using Gold Standard methodology.

Learners will grasp the fundaments of hyperbaric trial design and how one navigates various challenges and potential pitfalls that could otherwise cause quality failings and a resulting inability inform and guide clinical practice.

About the Speaker:
Dick assumed the position of president of the National Board of Diving & Hyperbaric Medical Technology in January, 2009, having previously held this position from 1989-1995. Dick's background includes service in the British Navy, diving instructor and underwater photographer at the International Underwater Explorers Society and assistant director of the seabed living program 'Hydrolab'. In 1976, Dick was instrumental in the development of the diver medic program at the Commercial Diving Center, while employed as a saturation diving superintendent with Oceaneering International. Dick taught the diving medicine section from 1976 - 1983 and helped establish the National Association of Diver Medic Technicians, the fore runner of the NBDHMT. He wrote the Board's first CHT exam. Over the past two decades Dick remains involved in all aspects of undersea and hyperbaric medicine, technology, education, and research. His organization has trained over 6,000 healthcare professionals and he has served as a faculty member for the annual NOAA-UHMS Diving Medical Officer Training Course for the past 25 years. Dick has been active within the UHMS, chairing numerous committees and was the UHMS Associates first elected chairman. He heads a research foundation dedicated to the scientific advancement of hyperbaric medicine and has developed an international consortium that undertakes wide-ranging controlled clinical trials.

Plenary: Shortage of 24/7 Facilities

10:30 am – 11 am
Jim Chimiak, MD



About the Lecture:
The decreasing availability of hyperbaric chambers for treating indicated emergency conditions continues. A variety of factors impact the situation. This presentation summarizes the current situation, measures currently employed, possible solutions, and the positive impact that current HBO2 research could have.

About the Speaker:
Dr. Chimiak is the Chief Medical Officer for DAN. He is triple boarded in Anesthesiology, Pain Management and Hyperbaric Medicine. Qualified as US Navy Special Operations, Flight Surgeon and Undersea/Saturation Diving Medical officers. He is co-chair of the dive committee for the UHMS.

Mass CO poisoning

11 am – 11:15 am
Geness Koumandakis, CHT

About the Lecture:
This lecture will be on a recent mass CO poisoning event in Utah. Geness will review carbon monoxide cases and discuss how Intermountain Health Hyperbaric department is working on developing a protocol of challenges to consider and obstacles that often get in the way.

Professional practice gap covered:
Triage and hyperbaric treatment decisions during mass poisoning events. Challenges faced during mass influx of patients.

Identify challenges and ideas to overcome them during mass CO events. There will also be a focus on triage decisions and carboxyhemoglobin levels vs symptoms when choosing who to treat.

About the Speaker:
Geness Koumandakis has been a registered respiratory therapist for 24 years and has been practicing critical care hyperbaric medicine for 22 of those years. She is currently the Hyperbaric Coordinator and Safety Director for LDS Hospital and Intermountain Medical Center in Salt Lake City, Utah. Koumandakis has been instrumental in training fellows from the Duke University hyperbaric fellowship program and has many years of experience as a clinical educator and presenter for various respiratory therapy, nursing, and nurse practitioner programs as well as the University of Utah pulmonary fellowship program. She has been a course instructor for multiple hyperbaric courses, including a course on critical care hyperbaric medicine. Koumandakis has been actively involved in multiple hyperbaric research studies and has co-authored several abstracts, journal articles, and recently co-authored a wound care book chapter. She has presented two of these abstracts at the UHMS conference and is the recipient of the 2019 UHMS Paul C. Baker award for hyperbaric oxygen therapy safety excellence. She currently sits on multiple hyperbaric oversight committees for Intermountain Healthcare and the UHMS.

DCI treatment debate: Shorter oxygen exposures vs US Navy treatment tables

11:15 am – 12:15 pm
Pablo Medina, MD (Pros) & Richard Moon, MD (Cons)

About the Lecture:
Introduction to Short No-Air Break Tables with an expanded knowledge of one table in particular (Hart-Kindwall) and comparison of this table with the USN TT6.

Professional Practice Gap covered:
UHM Practitioners may not feel comfortable treating Decompression Illness patients if they are not able to perform the most commonly known treatment (USN TT6) at their medical facility. This lecture aims to provide an alternative DCI treatment option (Short No-Air Break Table) that can be provided in almost any hyperbaric treatment facility.
Objectives:

- Gain familiarity with the concept of Short No-Air Break Tables
- Understand utilization of this treatment option in an oxygen-only monoplace chamber
- Understand treatment options available to a UHM practitioner when treating in a dual-gas monoplace chamber or multiplace chamber
- Understand the similarities and differences between the USN TT6 and Hart-Kindwall Table

About the Speakers:

Dr. Pablo Medina is a U.S. Air Force Lieutenant Colonel Pablo Medina, current Program Director for the San Antonio Uniformed Services Health Education Consortium Undersea & Hyperbaric Medicine Fellowship Program and Medical Director for the Brooke Army Medical Center Division of Undersea & Hyperbaric Medicine.

Dr. Richard Moon earned BSc and MD degrees at McGill University in Montreal, Canada, then trained in internal medicine and biomedical engineering at the University of Toronto. In 1979, he went to Duke to train in pulmonary and critical care medicine. After pulmonary/critical care fellowship he completed training in anesthesiology and in 1983 joined the Duke University faculty. He is Professor of Anesthesiology, Professor of Medicine, and Medical Director of the Duke Center for Hyperbaric Medicine & Environmental Physiology. His research has included the physiology of immersion and predictors of arterial PCO2 during underwater exercise. His work has included the role of patent foramen ovale (PFO) in decompression sickness (DCS). He has been particularly interested in causes and prevention of immersion pulmonary edema, a condition that continues to occur in Navy Special Forces trainees. He has been supported by several Navy grants, recently including use of an experimental breathing gas (perfluoromethane) to decrease decompression requirements after heliox dive. After completing human experiments demonstrating upregulation of mitochondrial biogenesis with low dose carbon monoxide exposure, he is currently studying its effect on training of the respiratory muscles. His work has also included mechanisms of sudden death during triathlons and causes of perioperative opioid-induced respiratory depression, and improved monitoring techniques for monitoring patients to detect it.

Tech's going off the reservation: Upholding the CHT Code of Conduct

12:15 pm – 1 pm
Dick Clarke, CHT-Admin

About the Lecture:
This presentation will summarize the genesis of the National Board of Diving & Hyperbaric Medical Technology (www.nbdhmt.org) and describe its certification programs. It will address Certification in Hyperbaric Technology in the context of a history of inappropriate professional behaviors that prompted introduction of the CHT Code of Conduct, in 2009. This Code outlines a set of rules that collectively represent responsibilities and practice expectations that reflect positively on the NBDHMT, the practice of hyperbaric medicine, and related patient safety. CHTs are required to document their Code of Conduct attestation upon initial certification and during each instance of recertification. The presentation will then describe instances and provide examples where violations of the Code of Conduct appear to have taken place. The process by which the NBDHMT investigates these reports, holds hearings, and makes sanction determinations (which range from Reprimand to Revocation), is then summarized.

About the Speaker:
Dick assumed the position of president of the National Board of Diving & Hyperbaric Medical Technology in January, 2009, having previously held this position from 1989-1995. Dick's background includes service in the British Navy, diving instructor and underwater photographer at the International Underwater Explorers Society and assistant director of the seabed living program 'Hydrolab'. In 1976, Dick was instrumental in the development of the diver medic program at the Commercial Diving Center, while employed as a saturation diving superintendent with Oceaneering International. Dick taught the diving medicine section from 1976 - 1983 and helped establish the National Association of Diver Medic Technicians, the fore runner of the NBDHMT. He wrote the Board's first CHT exam. Over the past two decades Dick remains involved in all aspects of undersea and hyperbaric medicine, technology, education, and research. His organization has trained over 6,000 healthcare professionals and he has served as a faculty member for the annual NOAA-UHMS Diving Medical Officer Training Course for the past 25 years. Dick has been active within the UHMS, chairing numerous committees and was the UHMS Associates first elected chairman. He heads a research foundation dedicated to the scientific advancement of hyperbaric medicine and has developed an international consortium that undertakes wide-ranging controlled clinical trials.

Monoplace hyperbaric chamber, equipment for treating critically ill patients

2 pm – 2:30 pm

Lindell Weaver, MD

About the Lecture:

This plenary presentation will describe equipment and care necessary to treat patients in a monoplace hyperbaric chamber. Equipment includes IV drug administration, operation of IV infusion pumps, the monitoring of ECG, invasive and non-invasive blood pressure; monitoring using pulmonary artery catheters, epicardial pacing, use of chest tubes; blood gas measurements and validity, and mechanical ventilation.

About the Speaker:

Dr. Weaver received a BS in Engineering Science from Arizona State University followed by medical school from the University of Arizona. He served a rotating internship in the US Navy, then went through the medical officer's course in Undersea and Submarine medicine and was an Undersea Medical Officer on the USS Canopis (AS-34) for two years. After discharged he served in the Naval Reserves with SEAL Team 1-3-5 for a few years. After discharge from Active Duty he trained in Internal Medicine, with fellowship training in pulmonary and critical care at the University of Utah. After completion of fellowship, he became the Medical Director of Hyperbaric Medicine and Co-director of the Shock Trauma Respiratory ICU at the Level One trauma center, LDS Hospital, Salt Lake City, Utah for 20 years. He was a co-investigator for the ARDSnet of the NIH and was the principal investigator of a randomized controlled trial of hyperbaric oxygen for acute carbon monoxide poisoning, published by the New England Journal of Medicine. He is a former president of the Undersea and Hyperbaric Medical Society. He has authored and co-authored hundreds of papers, abstracts, and book chapters. For 10 years he had a senior leadership role in the DoD effort to conduct blinded randomized trials of hyperbaric oxygen for post-concussive syndrome due to War-related mild traumatic brain injury. Research activities include study of neural auto-antibodies following carbon monoxide poisoning and a randomized trial of hyperbaric oxygen for sequelae months to years after brain injury. He enjoys off-road UTV and adventure motorcycle riding, SCUBA diving, and spending time with his family.

-INSERT paper-

Session E – HBO_2 Operations, Chambers and Equipment
ABSTRACTS

E60

ORAL PRESENTATION TIME: Sat, Jun 15, 14:30 - 14:40
POSTER PRESENTATION TIME: Sat, Jun 15, 15:00-15:30
RESIDENT COMPETITION: Yes

Improving Simulation Medical Education of Providers in Hyperbaric Medicine: A Survey Study

Gesell L, Luis Pacheco P, Spyratos K, Wankowski D, Riutta S
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Presenting Author: Krisos Spyratos DO
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Introduction/Background
Medical simulation is a modality of medical education that allows learners to practice clinical skills in an environment that closely emulates real patient encounters. Undersea and Hyperbaric Medicine (UHM) encompasses several procedures that are critical for providers to be competent but are relatively rare. Our UHM Department conducts a semi-annual simulation (SIM) lab, which allows providers to increase their familiarity with managing rare and critical patient situations.

Materials and Methods
Anonymous pre- and post-SIM lab surveys were distributed to 21 attending physicians, NPs, and PAs employed by the UHM department at a Fall 2023 lab. The surveys assessed provider knowledge and confidence of key UHM diagnoses, procedures, and complications. The survey question format was a combination of 5-point Likert scales to rate confidence and fill-in-the-blank knowledge questions. A Wilcoxon signed rank test was performed to test for significance.

Results
A significant increase in knowledge was found for all three procedures: myringotomy, needle decompression, and chest tube placement. Myringotomy had the largest growth of knowledge (Table 1). Increases in confidence in performing procedures were also observed following the SIM lab (Table 2). Respondents had a median 1-point confidence increase performing needle decompression and operating a defibrillator and a median 2-point increase for chest tube placement and myringotomy. No change was seen in respondents' confidence in identifying middle ear barotrauma, hypoglycemia, or pulmonary edema. An increase in confidence in identifying oxygen toxicity and pulmonary barotrauma was observed (Table 2).

Table 1: Percent Correct on Test of Procedure Steps. All reported values are median (IQR).

Total n = 20	Pre-Survey		Post-Survey		p-value
Needle Decompression	60%	(40 - 85)	100%	(80 - 100)	< .005
Chest Tube Placement	67%	(30.3 - 78)	94.5%	(67 – 100)	< .005
Myringotomy	17%	(0 - 37.3)	83%	(62.8 – 100)	< .005

Table 2: Self-Reported Confidence Performing Procedures and Identifying Disease Processes in a Clinical Setting. All reported values are median (IQR). Confidence measured on a 5-point Likert Scale where 1=least confident and 5=most confident.

Total n = 21	Pre-Survey		Post-Survey		p-value
Needle Decompression	3	(1 - 4)	4	(3 - 5)	< .005
Chest Tube Placement	2	(1 - 3)	4	(3 - 5)	< .005
Myringotomy	2	(1 - 4)	4	(4 - 5)	< .005
Defibrillator Operation	3	(1 - 3)	4	(3 - 5)	< .005
Pulmonary Barotrauma	3	(2 - 4)	4	(3 - 5)	< .005
Middle-ear Barotrauma	4	(4 - 5)	4	(4 - 5)	ns
Oxygen Toxicity	4	(3 - 5)	4	(4 - 5)	< .01
Hypoglycemia	5	(4 - 5)	5	(4 - 5)	ns

Summary/Conclusion
Increases in provider confidence in accomplishing key procedures, accurate recall of instructions on these procedures, and confidence in identifying pathology were observed following the SIM lab. By using regular integration of simulation into training and continued medical education for hyperbaric providers, we can maintain a standard minimal competency that will allow providers to practice confidently and safely as we can see the benefits of simulation training from our results.

E61

ORAL PRESENTATION TIME: Sat, Jun 15, 14:40 - 14:50
POSTER PRESENTATION TIME: Sat, Jun 15, 15:00-15:30
RESIDENT COMPETITION: No

Continuous blood glucose monitor performance in a 100% hyperbaric oxygen environment

Huang E, Hocking J, Walker T, Herring M
Legacy Emanuel Medical Center
Presenting Author: Enoch Huang, MD
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Introduction/Background
Patients wearing continuous glucose monitors (CGM) are frequently treated with hyperbaric oxygen (HBO2). Previous testing of the Dexcom G6 CGM in a hyperbaric air environment led some facilities to allow patients to wear them during HBO2 in a hyperbaric air environment but still require the removal of all manufacturers' CGMs in a 100% oxygen environment.

Materials and Methods
We obtained and tested a commercially available CGM (Dexcom G7, San Diego, CA) in a hyperbaric chamber (Hyperbaric Modular Systems, San Diego, CA). Each transmitter contains a 3V, 30mAh Lithium Manganese battery. Operational conditions for the transmitter are 50°F - 107.6°F with a humidity of 10-90%. The transmitter, battery, and printed circuit board (PCB) are contained inside a plastic external wearable device that is watertight, meets IP58 ingress protection standards, and is protected from submersion in water up to a depth of 8 feet for 24 hours. The operating altitude is -1253 to 16406 ft. Devices are sterile processed using ethylene oxide gas in a commercially rated process.

Sixty-eight (68) CGM's were hardwired to simulate a constant glucose signal. Thirty-four (34) of the CGMs underwent five daily, five-hour pressurizations to 3.0 atmospheres absolute (ATA) in a 100% oxygen environment.

Results
Transmitters were inspected before and after exposure for physical degradation. Transmitter performance was evaluated during and after exposure, and all transmitters performed within the expected parameters. Minimal fluctuation was noted during pressurization and depressurization, but none between 3.0 ATA and 1.0 ATA.

Summary/Conclusion
The CGM functioned within specifications in an HBO2 environment, and HBO2 did not cause physical damage to the transmitters. Fluctuations during pressurization and depressurization were determined to be artifacts from changes in chamber pressure. Safety concerns remain if the wearable device were damaged prior to HBO2. Further testing of a bare PCB in a 100% oxygen hyperbaric environment is currently pending.

E62

ORAL PRESENTATION TIME: Sat, Jun 15, 14:40 - 14:50
POSTER PRESENTATION TIME: Sat, Jun 15, 15:00-15:30
RESIDENT COMPETITION: No

Continuous blood glucose monitors and safety in the hyperbaric environment

Hocking J, Huang E, Walker T
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Introduction/Background
Hyperbaric oxygen (HBO2) can decrease blood glucose (BG) levels in patients with diabetes, and because of this risk, it is imperative to monitor BG in this population. As BG monitoring technology continues to advance, it is crucial that hyperbaric providers ensure the accuracy and safety of these advancements in pressurized environments.

Materials and Methods
We obtained and tested commercially available continuous glucose monitors (CGM) (Dexcom G7, San Diego, CA) in our HBO2 chamber. We had six G7 CGMs and three estimated glucose value simulator walkabouts (EGV WAB). Transmitters contain a 3V, 30mAh Lithium Manganese battery. Operational conditions for the transmitter are 50°F - 107.6°F with a humidity of ten to 90%. The transmitter, battery, and printed circuit board (PCB) are contained inside a plastic external wearable device that is watertight, meets IP58 ingress protection standards, and is protected from submersion in water up to a depth of eight feet for 24h. The operating altitude is -1253 to 16406 ft. The devices are sterile processed using ethylene oxide gas in a commercially rated process. The EGV WAB underwent an average of 13 exposures to 45 FSW (2.4 ATA) pressurizations in a multiplace HBO2 chamber. Data on the chamber environment was recorded. After the 10.5-day life of the transmitter, data was downloaded from the receivers, and the transmitters were sent back to Dexcom to be X-rayed to ensure the integrity of the devices after multiple hyperbaric exposures.

Results
The G7 CGM transmitter satisfies NFPA 99 Ch. 14 guidelines for battery-operated devices used in the hyperbaric environment. We did note some variance in BG levels during the hyperbaric treatment. Expert analysis of the CGMs showed no concerns or abnormalities after the repeated hyperbaric exposures.

Summary/Conclusion
Our testing did not show any safety concerns with repeated hyperbaric exposure of the Dexcom G7 CGM's. Testing of the CGM in monoplace hyperbaric conditions is currently pending.

E63

ORAL PRESENTATION TIME: Sat, Jun 15, 14:50 - 15:00
POSTER PRESENTATION TIME: Sat, Jun 15, 15:00-15:30
RESIDENT COMPETITION: No

3D printed IV pass-through for monoplace hyperbaric chambers

Georgen NS, Etoll E, Winn DA, Gorman BE, Cooper JS
Nebraska Medicine, 981150 NMC, Omaha, NE 68198
Presenting Author: Erin Etoll-Jones, MD; Jeffrey Cooper, MD
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Introduction/Background
When patients are receiving IV therapy while in a monoplace hyperbaric chamber, their IV tubing is attached to a connector sheath through the wall of the chamber, maintaining the air seal. Due to a diminishing number of hospitals offering this type of therapy, the sole remaining manufacturer of the specialized tubing and sheath has discontinued producing this product.

Materials and Methods
In response to the announcement of this discontinuation, our Hyperbaric Medicine Center nurses, in collaboration with a small multidisciplinary group, including an anesthesia resident with experience in 3D printing and engineering, began working on an alternative for the pass-thru portion of the discontinued product. They came up with a 3D-printed split bolt design that goes around IV tubing and seals the hole in the chamber door.

Results
The IV tubing to be used with our design needs to be firmer than standard IV tubing, leading us to use arterial line tubing. The tubing and device require a backflow preventer to be attached to replicate the safety of the discontinued product. Our Failure Mode and Effects Analysis group and institutional Risk Council evaluated and approved our new setup with this tubing and device. Pharmacy found that art line tubing is superior to standard IV tubing with respect to drug absorption.

Summary/Conclusion
We have obtained a temporary patent with the assistance of UneMed (the technology transfer & and commercialization office for the University of Nebraska Medical Center). FDA approval is possible to obtain, but there is a prohibitive cost to it.

Other sites are working on additional alternatives. Ours is safe and with the widespread availability of 3D printers, an inexpensive solution with the cost of plastic material being less than 25 cents per unit.

E64

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Sat, Jun 15, 15:00-15:30
RESIDENT COMPETITION: Yes

Delivering hyperbaric oxygen in the COVID-19 era: The effect of eliminating air breaks on incidence of oxygen toxicity seizure

Winn A, Masters T, Driver B, Popa, D, Logue, C.
Hennepin Healthcare
Presenting Author: Abigail Winn MD
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Introduction/Background

Oxygen toxicity seizures are a known side effect of hyperbaric oxygen treatment. Reported rates vary greatly. Many institutions utilize air breaks to decrease the risk. In March 2020, our institution stopped using air breaks to prevent the spread of COVID-19 in our multiplace chamber; we treat up to seven patients at a time. Our concern was that air breaks may increase the airborne transmission of viral particles. We hypothesized that while air breaks may decrease the incidence of oxygen toxicity, they do not do so in a significant manner.

Materials and Methods

We performed a single-site retrospective review of 40,179 routine hyperbaric oxygen treatments (Modified US Navy Treatment Table 9 max depth 2.4 ATA) in a multiplace chamber from 2015 to 2023. Approximately 23,646 with air breaks and 16,533 without. Cases of seizure activity were reviewed in our de-identified quality and safety data.

Results:

Seven cases of seizure-like activity were reported in the air-break group, and six cases in the no-air-break group. The seizure incidence was 0.03% (95% Confidence Interval 0.008%-0.05%) or 3 per 10,000 treatments in the air-break group and 0.04% (95% Confidence interval 0.008%-0.07%) or 4 per 10,000 treatments in the group without air breaks. The difference between the two groups was -0.01% (95% Confidence Interval -0.5%-0.02%).

Summary/Conclusions

The air-break group showed a decreased incidence of seizure, but not in a statistically significant manner. While air breaks may decrease the risk of oxygen toxicity seizure, they could increase the risk of airborne respiratory particle transmission and, therefore, respiratory illness, given the small, enclosed space of a multiplace chamber. Our institution has continued to treat most patients without routine air breaks after considering these factors.

E65

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Sat, Jun 15, 15:00-15:30
RESIDENT COMPETITION: No

Results of a campaign to improve the knowledge of referring providers related to the benefits of HBO2 therapy on late radiation tissue injury

Tettelbach WH, Christopher D
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Introduction/Background
Radiation therapy is a modality used to treat many forms of cancer, and about 50% of individuals receiving radiotherapy will be long-term survivors. A 2023 review of eighteen studies using Cochrane methodology with publications ranging from 1985-2022 suggested hyperbaric oxygen (HBO2) therapy may be associated with improved outcomes in patients with late radiation tissue injury (LRTI) affecting the head, neck, bladder, and rectum. Despite supporting medical evidence, patients experiencing symptoms of LRTI appear to be under-treated with HBO2 therapy secondary to a lack of understanding of HBO2 medicine by potential referring providers. This cursory analysis aims to determine if a nationwide educational campaign targeting LRTIs could favorably impact the number of patients who could benefit from HBO2 therapy.

Materials and Methods
A twelve-month LRTI education campaign was initiated on October 1, 2023, targeting local and regional oncology groups across North America. From October 2023 through January 2024, the total number of patients treated with HBO2 therapy and those specifically treated for LRTIs was collected. The comparator group was collected prior to the education campaign from June 2023 through September 2023. Statistical significance was calculated using Chi-Square.

Results
Within the first three months of the campaign, there was a 1% increase in the proportion of LRTIs receiving HBO2 therapy compared to all diagnoses treated.

June 2023 to Sept 2023:

- HBO2 LRTIs = 3,793
- HBO2 All Indications = 31,760

Oct 2023 to Jan 2024

- HBO2 LRTIs = 3,621
- HBO2 All Indications = 27,772

The chi-square statistic is 12.6913. The p-value is .000367. Significant at $p < .05$.

Summary/Conclusion
This cursory analysis suggests that patients suffering from LRTIs may never be offered HBO2 therapy as a treatment option to alleviate their pain and suffering secondary due to a lack of familiarity of referring providers with the benefits of Hyperbaric Medicine. A deeper analysis of this data will be performed at twelve months to validate these preliminary findings.

E66

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Thurs, Jun 13, 11:30-12:00
RESIDENT COMPETITION: No

Pseudoephedrine prophylaxis does not prevent middle ear barotrauma in hyperbaric oxygen therapy

Moayedi S, Gizaw A, Sweet S, Sethuraman K, Witting M
Department of Hyperbaric Medicine, R Adams Cowley Shock Trauma Center, University of Maryland School of Medicine, Baltimore, MD, USA, 21201
Presenting Author: Kinjal Sethuraman MD MPH
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Introduction/Background
A common complication of hyperbaric oxygen (HBO2) therapy is middle ear barotrauma (MEB), which can lead to pain, treatment abandonment, or delay in therapy. Studies have shown that pseudoephedrine decreases MEB for pressure changes in SCUBA divers and airplane travelers.

Materials and Methods
We conducted a randomized, double-blind, placebo-controlled trial to determine if pseudoephedrine is effective in decreasing MEB rates in patients receiving their first HBO2 treatment. Consenting patients enrolled in the study ingested a study pill at least 45 minutes, and no longer than 120 minutes, before the start of their first multi-place treatment.

Results
81 subjects were included in the comparison groups. 8/40 (20%) of the pseudoephedrine group and 11/41 (27%) of the placebo group required rescue oxymetazoline to help with compression. Three subjects in each group (7%) could not tolerate compression and aborted HBO2 therapy. There was no significant difference between the pseudoephedrine and placebo groups concerning ear pain ratings, tympanic membrane injury, or rescue medication to help with ear pressure equalization.

Summary/Conclusion
Pseudoephedrine prophylaxis, given between 45 minutes and 2 hours prior to multi-place HBO2 therapy, does not mitigate MEB or treatment delays. Further research with a larger patient population and varying HBO2 modalities (mono and multi-chamber) are needed to find a safe and reliable method to decrease MEB and prevent treatment delays or failures.

E67

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Thurs, June 13, 11:30-12:00
RESIDENT COMPETITION: No

B Braun Infusomat Space IV pump testing in the hyperbaric chamber

Fulmer, G, Heacock, K, Schroeder, M, Sethuraman KN
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Presenting Author: Gregory A. Fulmer, BTPS, RRT, CHT
gfulmer@umm.edu

Introduction/Background
There are no FDA-approved intravenous (IV) infusion devices for use in a multiplace hyperbaric oxygen chamber (HBO2). An institution-wide adoption of the B. Braun Space System prompted an operational and safety evaluation for use in our Class A chamber.

Materials and Methods
We tested six IV pumps at 1.0, 2.0, 2.4, and 2.8 atmospheres absolute (ATA). We initially tested the integrity of the pump functions and battery compartment temperature. Once safety was established, we tested flow rates for 1 ml, 5 ml, and 10 ml volumes of isotonic saline. The testing mimicked standard dive profiles used at our institution. The chamber was compressed to the desired pressures, and volume was measured via a syringe. We documented volumes at the following points: prior to compression, at the end of compression, at depth after 45 minutes, just prior to decompression, and at the end of decompression.

Results
We tested six IV pumps at 1.0, 2.0, 2.4, and 2.8 atmospheres absolute (ATA). We initially tested the integrity of the pump functions and battery compartment temperature. Once safety was established, we tested flow rates for 1 ml, 5 ml, and 10 ml volumes of isotonic saline. The testing mimicked standard dive profiles used at our institution. The chamber was compressed to the desired pressures, and volume was measured via a syringe. We documented volumes at the following points: prior to compression, at the end of compression, at depth after 45 minutes, just prior to decompression, and at the end of decompression.

Summary/Conclusion
The system functioned satisfactorily in the hyperbaric environment, and we recommend moving forward with its use in patients. We also recommend very close monitoring of patients receiving IV medications during compression.

E68

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Sat, Jun 15, 15:00-15:30
RESIDENT COMPETITION: No

Investigation of hyperbaric treatment facilities in Canada

LeDez KM, Zbitnew G, Ferguson S. Linden R.
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Presenting Author: Dr. Kenneth M. LeDez and Dr. Geoff Zbitnew
hyperbaricmedicinespecialist@gmail.com

Introduction/Background
Canada has a growing number of privately-run non-hospital facilities providing hyperbaric oxygen treatment (HBO2) for unapproved, "Off-label" conditions. This study reports and categorizes all Canadian HBO2 facilities (HBO2fs) and reviewed regulatory frameworks.

Materials and Methods
The study was conducted by online searches (plus some phone calls and personal contacts) for hyperbaric facilities in each Canadian Province and Territory, including inspection of website text and photos. HBO2fs were categorized as "On," "Off," or "On-Off" according to whether they restricted treatments to approved ("On"), unapproved ("Off"), or both ("On-Off") conditions, whether hospital or non-hospital, qualifications of those most responsible for clinical care (physician, naturopathic doctor, others). Regulations for non-hospital HBO2fs were reviewed for each jurisdiction.

Results
34 of the 43 (79%) HBO2fs identified were non-hospital. Only ten facilities (23.2%) were potentially available 24/7 for emergencies, just 9 in hospitals. Less than 1/3 of HBO2fs (13/30 = 30.2%) are "On" only. About half of all HBO2fs (21 vs. 22) have no physician, but where there is a physician, just 60% provide "On" HBO2 only, while 40% provide "Off-label" treatments also, and of the latter, 7/9 were in Ontario. Regulation of physician and naturopathic non-hospital HBO2fs is limited and restricted to western provinces and non-existent for non-physician HBO2fs.

Summary/Conclusion
Access to approved, emergency, and elective HBO2 is very limited and geographically uneven in Canada. 4 Provinces and all 3 Territories currently have no approved HBO2. "Off-label" HBO2fs greatly outnumber those treating only approved conditions. Ontario has 38.3% of the Canadian population (15.5/40.5 million) but 77.8% (7/9) of the physician HBO2fs that provide "Off-label" HBO2, likely explained by the lack of licensing and regulation for physician non-hospital HBO2fs. More robust regulations and public funding for approved HBO2 are needed to ensure safe, effective HBO2 access. The College of Naturopathic Physicians of BC recently prohibited HBO2.

E70

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Sat, Jun 15, 15:00-15:30
RESIDENT COMPETITION: No

POCUS in the multiplace chamber

Repollet C, Ray K, Siegel M, Van Meter K, Theriot B
LSUHSC Undersea & Hyperbaric Medicine 1816 Industrial Boulevard Harvey, Louisiana 70058
Presenting Author: Christian Repollet Otero
cmrepo@gmail.com

Introduction/Background
The safety, practicality, and utility of point-of-care ultrasound (POCUS) use in hyperbaric chambers has had limited investigation, with only a handful of articles published regarding the assessment of their use. Commercially available off-the-shelf handheld devices proven to function safely in hyperbaric chambers are even more scarce. Wireless connectivity eliminates touchscreen issues and fire hazards associated with mobile devices inside the chamber. This study evaluates the Sonostar C5PL as a safe and inexpensive alternative to higher-end devices for in-chamber use.

Materials and Methods
The Sonostar C5PL was initially tested in a Class C chamber on air to 2.8 ATA, and probe button functionality, device temperature, stability of the wireless connection, and device integrity were assessed prior to and after exposure. The device was then pressurized to 2.4 ATA on air in a Class A chamber while paired with an iPad outside the chamber, and the same metrics as above were evaluated once again, as well as image quality and range of connection inside the chamber.

Results
The Sonostar C5PL experienced automatic shut-off; due to power button depression, as described previously in the literature. Our device was modified accordingly and performed satisfactorily. The unit's highest operating temperature was 87.3°F (NFPA requires <185°F), with no loss of image quality (qualitative assessment based on baseline visual appearance outside the chamber), no interruption of wireless connection during pressurization was noted at 4, 6 and 8 feet from iPad, or compromise of device integrity as assessed by visual inspection and normal functionality of the device after pressurization.

Summary/Conclusion
The Sonostar C5PL is capable of adequate function, wireless connectivity, structural integrity, image quality, and acceptable operating temperatures at 2.4 ATA and 2.8 ATA on air. Though further testing is warranted, it appears to be a relatively safe potential option for POCUS in the multiplace chamber.

E71

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Sat, Jun 15, 15:00-15:30
RESIDENT COMPETITION: No

How to survive a Medicare TPE: The UCSD and UCLA experience

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Introduction/Background
Medicare uses TPE (Targeted Probe Education) reviews to reduce fraud/improve billing compliance. Reviews are initiated when charges increase over six months.

Materials and Methods
UCSD and UCLA underwent TPE reviews by Noridian, the Southern California Medicare Administrative Contractor (MAC), for CPT G0277 (Hyperbaric Oxygen Treatment) from 2018-2023.

Results

UCSD:

- 2018: 28% initial error rate. Three rounds/75 claims reviewed. Dismissed due to COVID pandemic.
- 2021: 31% initial error rate. Three rounds, 89 claims. Passed

UCLA:

- 2018: 20% initial error rate one round, 25 claims. Passed
- 2021: 63.3% initial error rate, two rounds, 60 claims. Passed
- 2023: 0% initial error rate, one round, 20 claims. Passed

Summary/Conclusion

1. TPE is an onerous administrative "hassle" because Noridian interprets "medical necessity" with their own criteria in addition to NCD 20.29.
2. Medical necessity denials are often reversed at the second level of appeal (Reopening).
3. Noridian does not track denials that are reversed on Reopening, so they do not revise their criteria when denials are overturned.
4. Noridian selects sequential service dates for review, resulting in multiple claims from a single patient, amplifying the error rate and increasing the likelihood of audit failure.
5. Successful TPE requires:
    a. A dedicated staff/consultant to work with facility clinicians, billing, and compliance to make sure deadlines are not missed
    b. Participating in TPE educational sessions when denials occur to learn the medical necessity interpretation that the MAC is using.
    c. Using checklists/templates to assist clinicians with medical necessity documentation
    d. Using the ABN form for cases when the MAC may deny the claim despite having a diagnosis allowed by NCD 20.29
    e. Billing dates of service separately, rather than bulk billing of claims, can result in a greater dollar loss if one date is denied.

E72

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Sat, Jun 15, 15:00-15:30
RESIDENT COMPETITION: No

Operational and patient characteristics of a new, hospital-based hyperbaric facility

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Introduction/Background
Previous studies have not described the operational and patient characteristics of a new hyperbaric facility. We describe patient volumes, treatment types, and patient characteristics for the first year of operations of a new, hospital-based hyperbaric facility.

Materials and Methods
St. Mark's Hospital in Salt Lake City, Utah, opened its hyperbaric facility on October 24, 2022, with two monoplace hyperbaric chambers. Associated with a new wound care clinic, the hyperbaric facility is located in an outpatient office building on the hospital campus. We reviewed clinic records and noted patient volumes, treatment types, patient characteristics, and referral patterns for all hyperbaric patients who initiated treatment during the first year of operations.

Results
Between October 24, 2022, and October 23, 2023, 27 patients received at least one hyperbaric oxygen treatment (HBO2) at the facility. The average patient age was 65 years (range: 37-88), and 25.9% of patients were female. Total patients initiating treatment varied by quarter (Q) of operations: 8 (Q1), 4 (Q2), 7 (Q3), and 8 (Q4). Indications for treatment included: delayed radiation injury (12 patients), osteomyelitis/Wagner grade 3 diabetic foot ulcer (8), idiopathic sensorineural hearing loss (3), compromised graft/flap (2), acute arterial insufficiency (1), and necrotizing soft tissue infection (1). The average number of treatments per patient was 34 (range: 1-112), while the average number of treatments per day was 3.6 (range: 0-8). 40.7% of referrals for treatment came from within the St. Mark's Hospital system.

Summary/Conclusion
In our first year of experience, we found that most indications for hyperbaric oxygen treatment were osteomyelitis and delayed radiation injury, while most referrals came from outside the hospital system. These trends and patient characteristics may provide guidance as new hyperbaric facilities anticipate needs for their first year of operations.

Session F – Top Case Reports
ABSTRACTS

F73

ORAL PRESENTATION TIME: Sat, Jun 15, 16:00 - 16:10
POSTER PRESENTATION TIME:
RESIDENT COMPETITION: Yes

Analysis of diver fatalities in San Diego: Insights from the SDDDRC

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Case Description

a. Case 1: A 33-year-old novice diver found kelp entangled, highlighting the challenges inexperienced divers face and the importance of dive buddies.
b. Case 2: A 44-year-old diver new to San Diego separated from the group during the post-dive surface swim, emphasizing the importance of cardiovascular screening.
c. Case 3: A 35-year-old lobster diver with limited local experience was found unconscious during ascent, underscoring the role of air management and safe ascent rates.

Intervention

The multidisciplinary teams that form the SDDDRC, featuring representatives from first responder agencies, diving medicine physicians, medical examiners, and diving safety officers, conduct thorough investigations into facets that lead to diver deaths. Synthesizing scene surveys, environmental conditions, medical data, witness reports, equipment evaluations, and medical examinations, this collaborative team meets to determine not only the cause and manner of death but also any disabling injuries.

Outcome

a. Diver 1: Entanglement/Panic
b. Diver 2: Cardiovascular Event
c. Diver 3: Arterial Gas Embolism

Discussion

Many are biased to label diving deaths as "drowning." Without the efforts of the SDDDRC, crucial and accurate data may be lost that could benefit the living diving population. The committee's role in identifying specific disabling injuries provides essential information for screening and prevention strategies, particularly in an aging diving population. The consolidation of SDDDRC data supports public health endeavors aimed at minimizing risks in diving. The analysis of these specific cases underscores the need for multidisciplinary teams to harness meaningful data from individual tragedies. The insights gained contribute to ongoing efforts to improve safety protocols and education within the diving community, as well as public health initiatives to minimize risk.

F74

ORAL PRESENTATION TIME: Sat, Jun 15, 16:10 - 16:20
POSTER PRESENTATION TIME: Sat, Jun 15, 15:00-15:30
RESIDENT COMPETITION: Yes

Significant cardiac and thrombotic effects of severe carbon monoxide poisoning: A case series

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Case Description
In addition to the well-known acute symptoms of carbon monoxide (CO) poisoning, CO poisoning can cause long-term morbidity, the most well-described of which is the development of delayed neurologic sequelae. CO poisoning can also have thrombotic and cardiac effects, especially in more severe cases. However, these are less well characterized. We describe four cases of severe CO poisoning with unique cardiac and thrombotic effects.

Intervention
Four patients with severe CO poisoning presented to the ED. All were intubated for altered mental status and had elevated troponins. All four patients underwent hyperbaric oxygen treatments at 2.8 atmospheres absolute for 45 minutes. Patient 1 had reduced cardiac ejection fraction (EF) on bedside transthoracic echocardiography (TTE) and developed an inferior vena cava thrombus. Patient 2 had reduced EF and developed a left ventricular thrombus. Patient 3 had a new wall-motion abnormality on TTE. Patient 4 had reduced EF, a new wall-motion abnormality, and ischemic changes on the electrocardiogram and underwent coronary angiography that was negative for occlusion.

Outcome
All four patients' cardiac functions and the new thrombi were evaluated with TTE, both in the ED and inpatient. Serial troponins and TTE helped monitor the recovery of cardiac function as well as track thrombi. EF returned to baseline in patients 1, 2, and 4 several days after the initial injury. Patients 1 and 2 were started on anticoagulation for their thrombi.

Discussion
The cardiac and thrombotic effects of CO poisoning can be significant. How long after poisoning these effects can persist is unclear. We believe it is imperative for providers in the ED to evaluate critically ill CO-poisoned patients with electrocardiograms, troponins, and TTE. For in-hospital follow-up of these patients, serial TTE to monitor for changes in cardiac function and new thrombi may be valuable.

F75

ORAL PRESENTATION TIME: Sat, Jun 15, 16:20- 16:30
POSTER PRESENTATION TIME: n/a
RESIDENT COMPETITION: Yes

Sickle cell disease-related SSNHL: A novel HBO2 indication?

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Case Description
A 17-year-old female with a history of Sickle cell disease (Hb-SS type), depression, migraine, and pulmonary embolisms on Dabigatran presented with acute hearing loss in her left ear. The patient had lost hearing in the right ear six months prior. At that time, an MRI of the brain with IAC showed hemorrhage within the right vestibule and semicircular canals. She was treated with oral steroids with no improvement in her hearing. An MRI brain with IAC was repeated on this presentation and showed hemorrhage within the vestibule and semicircular canals on the left side. The audiogram showed profound sensorineural hearing loss in both ears. She was referred for urgent hyperbaric oxygen therapy (HBO2).

Intervention
The patient was treated with hyperbaric oxygen therapy for 90 minutes at 2.4 ATA. Hyperbaric treatment was initiated 3 days after the onset of hearing loss. She received two doses of IV steroids and was transitioned to oral Prednisone 60 mg daily with a slow taper.

Outcome
The patient and her family subjectively noted hearing improvement early in treatment. The final audiogram after 19 treatments showed an improvement of 20-30dB at 250-1500 Hz compared to her initial audiogram.

Discussion
Sudden sensorineural hearing loss is a rare complication of Sickle Cell Disease due to labyrinthine hemorrhage. This patient had already lost the hearing in her right ear from a similar etiology, and we were able to salvage some hearing in her left ear. Idiopathic sudden sensorineural hearing loss is an approved indication for HBO2 and should be initiated as soon as possible with adjunctive steroid therapy. This case is an example of a rare etiology that also responded to HBO2 and steroids. We suggest that HBO2 be considered in future cases of sudden sensorineural hearing loss due to Sickle Cell Disease and labyrinthine hemorrhage.

F76

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Sat, Jun 15, 15:00-15:30
RESIDENT COMPETITION: No

Hyperbaric oxygen treatment of hydrogen peroxide enema-induced Pneumatosis intestinalis and Venous Gas Embolism

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Case Description
A 44-year-old female unintentionally gave herself a hydrogen peroxide enema, resulting in immediate rectal pain followed by hematochezia. She intended to perform a coffee ground enema but accidentally used hydrogen peroxide cleaning solution in the apparatus instead of coffee grounds. She presented to the Emergency Department promptly with abdominal cramping, dizziness, lightheadedness, and nausea. A CT revealed descending and rectosigmoid colitis with sigmoid pneumatosis intestinalis and diffuse peripheral portal venous gas. There was no free intraperitoneal air and no evidence of arterial gas embolism. She was transferred to the hyperbaric medical unit with a diagnosis of venous gas embolism (VGE) and pneumatosis intestinalis.

Intervention
The patient was treated urgently with hyperbaric oxygen (HBO2) utilizing a “Hart Kindwall” treatment table with no air breaks (2.8 ATA for 30 minutes; a five-minute decompression to 2.0 ATA; 60 minutes at 2.0 ATA). HBO2 treatments continued at 2.0 ATA for 90 minutes daily for six days (total HBO2 = 7).

Outcome
The patient experienced full resolution of her symptoms and was discharged from the hospital in stable condition. Repeat CT scan five days after admission did not demonstrate venous gas. She had improvement in the pneumatosis intestinalis and significantly improved the appearance of the large bowel. She has remained stable for eight months without a return of symptoms.

Discussion
This case demonstrates the dangers of introducing hydrogen peroxide into the gastrointestinal system and the positive impact of HBO2 therapy on this accidental self-induced venous gas embolism and pneumatosis intestinalis. Furthermore, this case demonstrates that a shorter treatment table may be acceptable for treating VGE when compared to a United States Navy Treatment Table 6.

F77

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Sat, Jun 15, 15:00-15:30
RESIDENT COMPETITION: Yes

Hyperbaric oxygen and fluorescence microangiography in the coordinated management of breast radiation injury

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Case Description
There are two million new patients diagnosed with breast cancer each year, many of whom require radiation therapy. Radiation can cause chronic changes to surrounding tissues, including fibrosis, skin thinning, and retraction, and can complicate surgical reconstruction. Predicting which patients will have difficulty healing, especially post-surgically, can be challenging. Fluorescence microangiography (FMA) is a tool to visualize microvasculature. It can identify inflammatory and ischemic areas of a wound and is helpful in evaluating healing progress and therapeutic response. Hyperbaric oxygen therapy (HBO2) is known to help mitigate symptoms of chronic radiation injury. However, HBO2, specifically used for breast radiation injury, has been less studied.

Intervention
We describe 14 patients with radiation injury to the breast who received HBO2. Ten of those had surgery prior to HBO2 initiation. Six patients presented with non-healing wounds, four had compromised surgical flaps, and four presented with pain and contracture. All patients underwent a course of HBO2 for their symptoms, and eight underwent concomitant FMA to monitor for changes in inflammation or ischemia.

Outcome
Five of the six patients with wounds healed completely with HBO2 and FMA was used to monitor healing progress (one patient was lost to follow-up). Two of the four patients with compromised flaps healed without further surgical interventions and one of those was monitored with FMA. The other two underwent revision surgeries and post-operative HBO2, and healing was monitored with FMA. Of the four patients with pain and fibrosis only, two were lost to follow-up, and two reported improved symptoms.

Discussion
In this 14-patient series of late radiation injuries to the breast who underwent HBO2, 10 of 11 who were seen at follow-up had improvement in their symptoms or wounds. FMA is a useful tool that was used to monitor healing and help determine how long to continue HBO2.

F78

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Sat, Jun 15, 15:00-15:30
RESIDENT COMPETITION: Yes

A case series of 5 patients with pneumothorax successfully treated with HBO2 without tube thoracostomy

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Case Description
We present a case series of five adult patients who received hyperbaric oxygen therapy (HBO2) with pneumothorax who did not receive tube thoracostomy. Pneumothoraces were identified on chest x-ray or CT chest imaging on initial presentation and were described as “trace” or “small.” Four patients were mechanically ventilated, and all had stable vital signs.

Intervention
HBO2 occurred in a multiplace chamber, with a physician or critical care nurse as the inside attendant under supervision by a board-certified USHM physician. Emergency thoracostomy supplies were immediately available inside the chamber in case of pneumothorax expansion. Pneumothoraces were evaluated with serial X-rays throughout the treatment course.

Outcome
A combined total of 38 HBO2 treatments were administered. No patient required emergent intervention during HBO2 or their clinical course. Chest X-rays in all patients after the first HBO2 showed stable, improved, or resolved pneumothorax. All patients received follow-up imaging after completion of HBO2 with no detectable pneumothorax.

Discussion
Untreated pneumothorax has long been an absolute contra-indication for HBO2 due to concern for the risk of expansion and tension pneumothorax during the decompression phase of treatment. However, we demonstrate that some patients with small pneumothoraces who would not otherwise require intervention, despite invasive positive pressure ventilation, can receive HBO2 with proper safety measures. We hope our case series is taken into consideration by clinicians (particularly in resource-limited settings) when weighing the risks and benefits of treating emergent or critically ill patients. Conservative management should be limited to those with small or trace pneumothorax. Larger studies are needed to definitively determine the feasibility of conservative management of pneumothorax in HBO2.

F79

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Sat, Jun 15, 15:00-15:30
RESIDENT COMPETITION: No

Cold urticaria preventing clearance for scientific diving

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Case Description
We present a case of a 39-year-old otherwise healthy female scientific diver who developed cold urticaria (CU) eight months prior, when immediately postpartum. She had extensive swimming and diving experience but had discontinued diving during pregnancy and now sought to resume diving. Prior to our consultation, she had seen a dermatologist and an allergist for evaluation for an underlying etiology and symptom management.

Intervention
Initial management included diphenhydramine and cetirizine with topical triamcinolone based on dermatology recommendations. Given breastfeeding concerns, her allergist later advised discontinuing diphenhydramine and remaining on cetirizine 10mg up to four times daily. Epinephrine was also prescribed in case of anaphylaxis.

Outcome
The workup revealed no underlying pathology, and she was not cleared for diving until her CU was resolved. Despite antihistamines, she continues to develop urticaria to cold stimuli, including pools heated to 90 degrees F. Although drysuit certified, we were unable to clear her for scientific diving and advised against recreational diving, given the possible risk of anaphylaxis.

Discussion
CU is an uncommon but likely under-reported and under-recognized condition with potentially fatal consequences for swimmers and divers. Although symptom management focuses on antihistamines, corticosteroids and omalizumab (Xolair®) may also prove useful. Nonetheless, the risk of anaphylaxis remains, so CU should be a disqualifying condition for divers. Associated and causative conditions require specialist evaluation, with many patients reporting spontaneous resolution within several years. Hyperbaric physicians should be aware of CU not only as a disqualifying condition but also as an etiology of a post-diving rash that could be mistaken for skin manifestations of decompression sickness.

F80

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Sat, Jun 15, 15:00-15:30
RESIDENT COMPETITION: Yes

A mysterious CAGE and the man inside

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Case Description
A 49-year-old male of Asian descent with a past medical history of stage three chronic kidney disease, atrial fibrillation treated with anticoagulation, hypertension, and dyslipidemia presented to the emergency department (ED) following a fall down four stairs. The patient (DP) reported awakening, feeling weak, and as he tried to walk from his bed, fell down the stairs. When DP's significant other found DP at the bottom of the stairs, she noticed a left-sided facial droop, left leg, and left arm weakness. DP was brought to the ED and underwent evaluation for acute stroke. CT of the head and neck showed diffuse right greater than left pneumocephalus and complete occlusion of the left ICA. DP also sustained multiple rib fractures, left pulmonary contusion, and left pneumothorax for which a chest tube was inserted.

Intervention
The hyperbaric medicine team was consulted for the treatment of cerebral arterial gas embolism. The patient was treated with a US Navy treatment table 6.

Outcome
At 60 minutes into treatment at 60 feet of seawater, DP's facial droop and left leg weakness had resolved. The left arm weakness did not improve. No further hyperbaric treatments were performed. Repeat imaging demonstrated the resolution of pneumocephalus. The patient was eventually discharged to an acute rehabilitation facility.

Discussion
Arterial gas embolisms and treatment with hyperbaric oxygen (HBO2) are well documented in diving and medical literature. DP's case does not clearly demonstrate the origin of the cerebral air. Our working hypothesis is air was released into the vasculature resulting from pulmonary trauma. DP likely had a stroke causing ischemia to the right MCA affecting the left arm motor complex, whereas the facial and left leg areas were within the penumbra and were able to be rescued.

F81

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Sat, Jun 15, 15:00-15:30
RESIDENT COMPETITION: No

Respiratory decompensation during hyperbaric oxygen therapy in a patient with severe aortic stenosis

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Case Description
We present a case of a 77-year-old female with congestive heart failure and previously mild aortic stenosis who experienced an adverse respiratory event during hyperbaric oxygen therapy for a diabetic foot ulcer. She had a history of CHF exacerbation two years prior, but her LVEF had recovered, and she was on a stable dose of diuretic without recent exacerbation. She was treated at 2.0 ATA for 90 minutes of total bottom time with no air breaks and planned once-daily treatments. On her fourth treatment, she had an abrupt onset of chest pain and shortness of breath near the end of her treatment while still at treatment pressure. On the surface, she had visible dyspnea but no rales. She denied any recent illness or change in her medication.

Intervention
Her symptoms resolved within ten minutes. Further workup in the emergency department noted normal troponin, normal pro-BNP, and chest x-ray without pulmonary edema.

Outcome
We decided to pause her course of hyperbaric treatment. Later, a repeat echocardiogram showed normal LVEF but new diastolic dysfunction and now severe aortic stenosis. She underwent aortic valve replacement. Repeat echocardiogram noted normal LVEF, unchanged diastolic dysfunction, and now post-surgical aortic valve. Two months later, she completed a course of 10 hyperbaric treatments without incident or return of her symptoms.

Discussion
Patients with congestive heart failure are known to be at risk for flash pulmonary edema while undergoing hyperbaric oxygen therapy. In this case, we posit that her aortic stenosis was the cause of her in-chamber event. First, she had no edema during either event (absence of rales and clear chest x-ray), indicating something other than congestive heart failure. In addition, she received an aortic valve replacement and was later able to tolerate hyperbaric oxygen therapy without incident despite persistent diastolic dysfunction.

F82

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Sat, Jun 15, 15:00-15:30
RESIDENT COMPETITION: Yes

Hyperbaric oxygen therapy to mitigate anoxic brain injury post-cardiopulmonary arrest

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Case Description
Anoxic brain injury (ABI) following cardiopulmonary arrest has devastating consequences with significant morbidity and mortality. We report on a 60-year-old man with global ABI following an out-of-hospital cardiac arrest due to an unwitnessed tracheostomy dislodgement after the return of spontaneous circulation (ROSC). The patient initially presented from an outside hospital following the event with findings concerning ABI. During the first several days, he had a significant neurological decline, and MRI and EEG findings were consistent with profound hypoxic-ischemic injury.

Intervention
Following stabilization, with the patient on Trach collar 11 days after the event, he was treated sub-acutely with ten days of hyperbaric oxygen therapy of 2.5ATA for 60 minutes. The patient has continued treatment as able, re-assessing after every ten treatments.

Outcome
The patient is no longer in a coma and is in between a vegetative and minimally conscious state. His Glasgow Coma Scale (GCS) improved from 4T (E1V1M2) to 6T (E2V1M3) while undergoing the first ten treatments. Following twenty more over a few months, to GCS 10T (E4V1M5).

Discussion
Following cardiac arrest with ROSC, the brain is injured initially by ischemia and, subsequently, a secondary injury triggered by reperfusion occurring acutely in the resuscitative and post-resuscitation phase. At the cellular level, there is cessation of aerobic metabolism and all that follows, leading to cell injury and death, as well as an inflammatory response. Hyperbaric oxygen therapy is an established adjunctive treatment to decrease ischemic tissue damage in some cases. With early use, it should mitigate the phenomena of ischemia-reperfusion injury in many tissues, including the brain.

F83

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Sat, Jun 15, 15:00-15:30
RESIDENT COMPETITION: Yes

Position change during hyperbaric oxygen therapy for arterial gas embolism

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Case Description
A 78-year-old man with severely reduced heart function underwent cryoablation for chronic atrial fibrillation. During the procedure, he accidentally inhaled rapidly. Subsequently, he presented with stroke symptoms. Computed tomography (CT) revealed air in the brain and left ventricle, leading to a diagnosis of arterial gas embolism.

Intervention
The patient was carefully placed in the supine position. Six hours after onset, the patient underwent hyperbaric oxygen (HBO2) therapy as per the US NAVY Table 6 protocol. The air embolism in the brain reduced, but that in the apex of the left ventricle persisted. Subsequently, HBO2, as per the US NAVY Table 5 protocol, was performed along with a position change to the right lateral and manual vibration. We raised the patient's upper body slightly and rotated it to the right lateral position during the session. Furthermore, we vibrated the trunk for a minute during HBO2 to encourage air to pass toward the descending aorta rather than to vessels coming off the aortic arch.

Outcome
After the second HBO2 session, the air in the left ventricle disappeared; brain CT showed no worsening in the brain. We were convinced that the air in the body was eliminated and initiated rehabilitation. Although the patient's left hemiparesis persisted, we avoided a fatal outcome.

Discussion
We successfully treated the patient who presented with an iatrogenic arterial gas embolism using a combination of unusual positional changes and vibration during HBO2. This case suggests that the three-dimensional anatomy of the cardiovascular system should be considered when determining patient position before and during HBO2 for effective treatment of arterial gas embolism.

F84

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Sat, Jun 15, 16:30-17:00
RESIDENT COMPETITION: Yes

Hyperbaric therapy for a hypertensive pathology: Hyperbaric oxygen therapy in a case of Martorell's hypertensive ulcer

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Case Description
Hyperbaric Oxygen Therapy (HBO2), a known adjunctive therapy for problem wounds, is particularly well-established for diabetic foot wounds, surgical flaps, ischemic insult, and radiation damage. A more rare problematic wound is Martorell's ulcer, a lower extremity wound afflicting patients with long-standing, poorly controlled hypertension. There is limited guidance on the management of these cases, with an even greater paucity of information regarding any role of HBO2.

This report presents a case of Martorell's ulcers treated with HBO2 and standard wound care. Dermatology providers made the diagnosis, and alternative diagnoses were excluded. At the onset of the HBO2 course, there were three wounds across the distal lower extremities.

Intervention
The patient was treated with 60 HBO2 sessions at 2.0 ATA for 120 minutes over 13 weeks, once daily, four to five times per week. The patient's long-term care facility provided standard wound management, plus weekly dressing changes with photographs in the hyperbaric clinic.

Outcome
Over the treatment course, the smallest wound resolved. The intermediate and largest wounds showed some decrease in size and significantly improved appearance of the wound bed, from poorly vitalized state to fully proliferated granulation tissue and signs of burgeoning epithelialization. This progress led the primary wound care team to pursue biologic allograft, where the tissue had previously been considered too unhealthy to sustain such intervention.

Discussion
HBO2 is well established in augmenting healing in multiple etiologies of problem wounds. Martorell's ulcer is a rare wound etiology with very minimal management guidance. Per this author's review, there are no more than two cases in existing literature that incorporated HBO2 in management. This case, monitored over a thirteen-week course of 60 HBO2 sessions, saw overall health and viability of the affected tissue improve, suggesting Martorell's ulcer is another problem wound in which hyperbaric oxygen may play a therapeutic role.

F85

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Sat, Jun 15, 16:30-17:00
RESIDENT COMPETITION: Yes

Fulminant decompression illness in a recreational diver without significant omitted decompression

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Case Description
A 57-year-old male presented with left upper extremity weakness, nausea, and generalized malaise starting ten minutes after surfacing from a second recreational dive that day. He had bowel incontinence and vomiting en route. He arrived with normal vital signs except mild tachycardia. The initial exam was notable for subtle right lower facial droop, left upper extremity paralysis, and mild weakness in the other extremities. He was unable to perform coordination tests.

Labs were drawn in the emergency department, and he was immediately transported to the hyperbaric chamber for treatment of decompression illness (DCI). He decompensated during treatment, requiring intubation and cardiopulmonary resuscitation. Laboratory evaluation revealed multi-organ injury and hemoconcentration. Imaging revealed multifocal intravascular air.

Intervention
He was admitted to intensive care on vasopressors and required ventilator support for three days. Multiple specialists were involved in his care to explore other etiologies for his clinical deterioration. With concern for stroke and cardiac injury in the setting of hyperviscosity, the patient underwent therapeutic phlebotomy and was started on a heparin drip. He received 14.5 liters of fluids and 13 hyperbaric treatments with significant improvements in his motor function, speech, and coordination.

Outcome
Upon discharge to an acute rehabilitation center, he was ambulating with assistance, eating independently, and able to draw a clock. He then continued with outpatient physical and occupational therapy.

Discussion
Shock and capillary leak syndrome are rare manifestations of DCI, typically after rapid ascent or significantly omitted decompression from deep dives. Clinical indicators reported in the literature include polycythemia, hypoalbuminemia, and decompensation despite timely hyperbaric treatment. Our patient had an extensive evaluation to explore the differential but ultimately required aggressive fluid resuscitation, supportive care, and hyperbaric therapy, consistent with cases reported in the literature. This case highlights the importance of our guidance to help educate providers less familiar with these challenging DCI cases.

F86

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Sat, Jun 15, 16:30-17:00
RESIDENT COMPETITION: Yes

Case report: Hyperbaric oxygen therapy for carbon monoxide poisoning in the third trimester of pregnancy

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Case Description:
A 30-year-old female, G11P3163 at 32w6d gestation, with a history of methamphetamine use and migraines, presented to an emergency room after the unknown duration of exposure to carbon monoxide from a trailer fire with signs of inhalation injury. Her carboxyhemoglobin level on site was 13% and fetal monitoring had an average heart rate in 130s with reduced beat-to-beat variability. The mother was hemodynamically stable and neurologically intact. She received one treatment of hyperbaric oxygen therapy (HBO2) to reduce the risk of pregnancy complications.

She tolerated the treatment well, but there was a deceleration in fetal heart tone that was self-limited in two minutes. At 38w3d gestation, the patient had a cesarean section delivery due to the break in the amniotic membrane and a history of prior cesarean section.

Intervention:
US Navy Treatment Table 6

Outcome:
HBO2 for carbon monoxide poisoning in the third trimester of pregnancy was safe.

Discussion:
Carbon monoxide is a colorless and tasteless molecule that has 200 to 250 times higher affinity to hemoglobin than oxygen, impairing the oxygenation of organs and tissues, which could lead to life-threatening symptoms, such as seizures, coma, and hemodynamic compromise. In pregnancy, carbon monoxide crosses over the placental barrier via diffusion with an estimated seven-hour half-life on fetal hemoglobin, compared to approximately two-hour half-life on maternal hemoglobin. Slower dissociation of carbon monoxide from the fetal hemoglobin may result in delay and longer duration of carbon monoxide poisoning manifestations. In this case, the change in fetal heart tone supports the longer duration of carbon monoxide on fetal hemoglobin than that on maternal hemoglobin, which may contribute to the inconsistency in symptoms between the mother and the fetus. It also supports that HBO2 is safe for the treatment of carbon monoxide poisoning in the third trimester of pregnancy.

F87

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Sat, Jun 15, 16:30-17:00
RESIDENT COMPETITION: No

Importance of 4-D CT for recurrent hyperparathyroidism in calciphylaxis

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Case Description
A 45-year-old female was referred to hyperbaric medical services for treatment of biopsy-confirmed calciphylaxis wounds on her legs. History was significant for two prior failed renal transplants, resulting in dependence on hemodialysis three times per week. She had SVC syndrome from a left subclavian dialysis line treated initially with Warfarin, then switched to Apixaban. Surgical history revealed prior parathyroidectomy and current parathyroid hormone (PTH) levels at 1412 ng/L. 2 months after starting hyperbaric oxygen therapy, the patient had a repeat parathyroidectomy, and PTH decreased to 32 ng/L. Her wounds healed after 88 hyperbaric treatments, but unfortunately, her wounds recurred five weeks later, and PTH levels increased to 219 ng/L. Removal of forearm parathyroid remnant was performed, but PTH levels remained elevated.

Intervention
Repeat ultrasound imaging and parathyroid scan with SPECT CT failed to reveal the focus of enhanced parathyroid hormone production after the forearm remnant was removed. 4D-CT scanning revealed a soft tissue nodule that demonstrated contrast wash out in 90 seconds, unlike lymph nodes. This tissue focus was not present on CT imaging of this region six months earlier.

Outcome
The patient underwent left hemithyroidectomy, left neck dissection, and repair of thoracic duct defect to remove the ectopic tissue. Hyperbaric oxygen therapy was continued for a total of 121 sessions with complete healing of the patient's wounds.

Discussion
Recurrent calciphylaxis wounds should prompt re-evaluation of parathyroid hormone levels, even in patients with prior parathyroidectomy. Over time a small focus of parathyroid tissue may hypertrophy into an ectopic source of tertiary hyperparathyroidism. 4D-CT scanning may be a useful modality in the investigation of this issue.

F88

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Sat, Jun 15, 16:30-17:00
RESIDENT COMPETITION: No

Hyperbaric oxygen in treatment-resistant eczematous dermatitis

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Case Description
Case Description
A 45-year-old male was referred by dermatology for consideration of HBO2 for severe, resistant eczematous dermatitis complicated by repeated bacterial infection of superficial skin wounds due to uncontrollable pruritis, requiring intravenous antibiotics. Lifelong antecubital eczema was previously responsive to topical therapies but worsened greatly following Moderna™ COVID-19 vaccination, with weeping lesions to the head, neck, chest, abdomen, back, arms, groins, and genitalia. Profound functional limitation with severe pruritus, impaired ambulation, sleep, and discomfort aggravated by clothing prevented working and normal activities. Prednisone, JAK inhibitors, Dupilimab, Tralokinumab, and Methotrexate provided inadequate relief.

Intervention
After clinical ethical review support, HBO2 commenced (2.4ATA 90 minutes, five-minute air-breaks), complicated only by unilateral grade two otic barotrauma. He was started on Ustekinumab after HBO2 37 and reported mild myopia following treatment 40.

Outcome
Improvement began within 8 HBO2 demonstrated by functional capacity and quality of life. A mild relapse occurred after 19 HBO2, but subsequently, there were further improvements in pruritus, sleep quality, comfort, and ambulation, which enabled wearing regular clothing. Cutaneous manifestations improved markedly with reduced erythema, excoriation, lesion burden and a significant reduction in lesion weeping such that he was able to use bedding more than once.

Discussion
Atopic dermatitis (AD) is among the worst autoimmune dermatological disorders, with a high prevalence characterized by multiple clinical manifestations. Treating severe, relapsing AD is challenging, and advanced pharmacological immunomodulatory therapies have frequent debilitating side effects. HBO2 increases cellular reactive oxygen species (ROS) and creates an immunosuppressive environment by increasing regulatory T cell function and suppressing proinflammatory cytokines and transcription factors. This case emphasizes the potential benefits of adjunctive HBO2 in reducing morbidity associated with severe, treatment-resistant AD and the need for further research and clinical trials.

F89

ORAL PRESENTATION TIME: n/a
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RESIDENT COMPETITION: Yes

An extraordinary carbon monoxide poisoning incident

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Case Description
A devoted father decided to warm his van in an enclosed garage before taking his family to morning church services. When a neighbor heard the car running in the enclosed garage, he investigated, found all five family members unresponsive, and called the paramedics. The two sons and father were dead, while the daughter & mother were comatose but alive. The females were transported to a medical facility that had hyperbaric oxygen (HBO2) available.

Intervention
After intubation, HBO2 treatments were started while medical management continued. Each day, the patients became more responsive to painful stimuli.

Outcome
On the tenth hospital day, the daughter began making violent non-seizure movements while in the chamber and tried to chew through her endotracheal tube. The chamber was depressurized, and she was extubated. Although lethargic, she was able to respond to simple commands. After a couple of days, her sensorium cleared fully. She subsequently returned to school maintaining her honor student status. On the 14th day, the mother emerged from her comatose state. It was later learned that the mother assumed her husband's gardening business—and was even more successful with it than her husband had been.

Discussion
Several "why's" are raised with this incident. First, why did the females survive? Dr. George Hart's seminal work with tissue gas exchange may provide an explanation. Dr. Hart found that females onload oxygen better than males. Perhaps this gender difference kept the females alive. Second, why were HBO2 treatments continued beyond three days? Our protocol is to continue HBO2 treatments until the patients' responses plateau. Third, why did neither survivor develop latent encephalopathy? This was attributed to the immediate initiation of HBO2 treatments. This extraordinary incident is presented to make HBO2 providers aware of the benefits we observed with extended HBO2 treatments in comatose patients.

F90

ORAL PRESENTATION TIME: n/a
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RESIDENT COMPETITION: Yes

A forefoot mal perforans ulcer challenge

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Case Description
A 64-year-old male diabetic was admitted with forefoot sepsis and a mild leukocytosis attributed to underlying osteomyelitis (OM) of the 2nd metatarsal (MT) head. He previously had a partial 3rd ray amputation. An MRI study was "highly suspicious" for OM involving the 2nd and 3rd MT heads. Hyperbaric oxygen (HBO2) treatments were started for suspected OM. A transmetatarsal amputation (TMA) was recommended, but the patient requested a second opinion with the goal of avoiding it. Our case report demonstrates how to optimize the evaluation and management of the forefoot MPU.

Intervention
A single photon emission computerized tomography (SPECT) scan demonstrated an infected bursa but no OM. With this information, we addressed the biomechanical (clawed, retracted toe) and infected bursa problems to avoid a TMA. Minimal invasive surgery (MIS), including extensor tendon tenotomy and redirecting the MT dorsally with scoring the MT neck with percutaneous drill holes and osteoclasis plus excision of the infected bursa, was performed.

Outcome
The plantar MPU healed after seven weeks, and weight-bearing with a post-op shoe was allowed after the third week. About a year later, a transfer Stage-1 (superficial wound) MPU developed under the 4th MT head. This was managed as above, and the superficial wound healed primarily.

Discussion
Several lessons can be gleaned from this case report. First, the specificity of detecting OM in the foot with MRI is poor since the study detects bone edema but not infection. Second, the SPECT scan adds accuracy for detecting OM. Third, biomechanical problems are invariably associated with forefoot MPU and can be managed with MIS and almost always result in healing. Fourth, HBO2 should be used for MPU when sepsis is present (Stage-2 MPU), MT head OM is confirmed (Stage-3 MPU) or necrotizing soft tissue infection/ascending tenosynovitis threatens limb amputation (Stage-4 MPU).

F91

ORAL PRESENTATION TIME: n/a
POSTER PRESENTATION TIME: Sat, Jun 15, 16:30-17:00
RESIDENT COMPETITION: Yes

Hyperbaric oxygen (HBO2) therapy for penile glans necrosis after non-target embolization: Delayed referrals may still benefit

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Case Description
A 69-year-old male presented to Hyperbaric Medicine for a necrotic ulcer at the tip of the glans penis. Discoloration and pain developed one day after undergoing a bilateral prostate artery embolization (PAE) for benign prostatic hyperplasia (BPH). The patient's lesion continued to expand in the following weeks with overlying eschar, and he was diagnosed with non-target embolization (NTE). He experienced severe pain and dysuria. There was no significant improvement despite medical management with daily tadalafil (increased from 5 mg to 10 mg), aspirin 81 mg, and local wound care. He requested a referral to Penn Hyperbaric Medicine after his own review of the literature, at which point he was five weeks post-procedure.

Intervention
Hyperbaric oxygen (HBO2) was initiated 40 days after the procedure. He underwent ten once-daily treatments at 2.0 ATA for a total of 120 minutes of oxygen with a five-minute air break. There were no complications related to treatment. He continued daily tadalafil and aspirin for one week after completing HBO2.

Outcome
After treatment five, the necrotic region sloughed with decreased pain and reduced dysuria. By treatment ten, the eschar was no longer present, and the underlying glans tissue appeared well-perfused. His pain was significantly improved, and his dysuria was fully resolved. At six months post-treatment, he reported full resolution of the lesion.

Discussion
Non-target embolization (NTE) is a rare but known risk of PAE. While some cases are self-limited, distal ischemia and necrosis can result in significant morbidity. Previous case studies utilizing HBO2 for the treatment of glans penis necrosis due to NTE have initiated therapy within 5-14 days post-procedure. This case demonstrates the fortunate benefit of HBO2 as far as 40 days post-procedure but also demonstrates an opportunity to develop protocols for expedited referral with our interventional colleagues.

F92

ORAL PRESENTATION TIME: n/a
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RESIDENT COMPETITION: No

A case report on hyaluronic acid filler embolism treated with hyperbaric oxygen therapy

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A 37-year-old female patient presented to the hyperbaric oxygen department with a three-day history of vision loss in her right eye following the injection of hyaluronic acid filler into her nasal dorsum. She also reported cyanosis and pain in the nasal area and right periorbital region. Digital Subtraction Angiography (DSA) of the cerebral vessels revealed an obstruction in the branches of the right ophthalmic artery. The patient's medical history was devoid of related conditions.

Intervention
Physical examination revealed cyanosis, as well as redness and swelling extending from the nose to the forehead (Panel A and inset). The right eye demonstrated a complete absence of light perception, ptosis of the upper eyelid, eyelid edema, immobility of the eyeball, minimal conjunctival hemorrhage, corneal edema, dilated pupils measuring approximately 5.5mm, irregular pupil shape, absence of light reflex, and grayish-white lens opacity. Intraocular pressure was recorded as TN-2 (Panel B and inset).

Outcome
The diagnoses included:

- obstruction of the right ophthalmic artery,
- skin necrosis induced by hyaluronic acid and
- a secondary cataract in the right eye.

The patient received hyperbaric oxygen therapy at 2.4 ATA for two sessions daily, each lasting 135 minutes, for two weeks, followed by a reduction to one session daily for an additional two weeks with adjunctive niacin therapy. The patient exhibited hypertrophic scarring on the forehead, mild atrophy of the alae nasi, partial opening of the right eye with associated atrophy and enophthalmos, and corneal improvement. At the 45-day follow-up, the patient demonstrated significant facial improvement (Panel C).

Discussion
This case highlights the potential value of hyperbaric oxygen therapy in treating embolisms caused by hyaluronic acid fillers despite limited direct effects on vision restoration.

F93

ORAL PRESENTATION TIME: n/a
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RESIDENT COMPETITION: No

Improved musculoskeletal pain and range of motion following hyperbaric oxygen treatment for delayed radiation soft tissue injury in two breast cancer patients

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Case Description
Women treated for breast cancer with radiation often develop painful, debilitating fibrosis of the breast, chest wall, and shoulder. Capsular contracture may be seen in 40-50% of patients receiving radiation treatment after breast reconstruction. These complications can also occur using lumpectomy and radiation without implant-based reconstruction. Although hyperbaric oxygen (HBO2) treatment is used frequently for delayed radiation injury, whether HBO2 improves fibrosis and pain has not been established. We describe two such cases treated with HBO2.

- Case 1 A 64-year-old woman with breast cancer treated with partial mastectomy and 52.6 Gy of postoperative radiation therapy developed fibrosis, pain, and limited range of motion in her left arm and shoulder. Symptoms persisted for over one year despite the ongoing range of motion exercises with a personal trainer.
- Case 2 A 56-year-old woman had a left partial mastectomy and 52.6 Gy of radiation treatment for ductal carcinoma in situ (DCIS) but developed recurrent DCIS with invasive carcinoma in the same breast five years later. She elected bilateral mastectomies with reconstruction and implants. Within two years, she developed increasing pain and fibrosis. She maintained a good left-arm range of motion with yoga but was functionally limited by pain two years after treatment.

Intervention
Both women received 40 daily, 90-minute HBO2 treatments (5 days/week) at 2.4 ATA. Patient 1 continued ROM exercises with her trainer, and Patient 2 continued self-directed yoga exercises.

Outcome
Both patients reported improved functional levels associated with a steady decrease in pain. Patient 1's baseline pain improved from 4/10 to 0/10. Her left arm ROM also improved measurably. Patient 2's pain decreased from 5/10 to 2.5/10.

Discussion
HBO2 treatment may reduce pain, lessen fibrosis, and improve mobility in women with pain and fibrosis after breast cancer treatment that includes radiation.

F94

ORAL PRESENTATION TIME: n/a
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RESIDENT COMPETITION: No

Subcutaneous emphysema and intraperitoneal bladder rupture due to self-injurious behavior: Treatment experience with hyperbaric oxygen therapy

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Case Description
A 42-year-old male visited the emergency department with sudden abdominal pain during masturbation, a practice he had engaged in for about ten years by injecting hot water into his urethra using a homemade hose. Physical examination revealed abdominal guarding. A contrast-enhanced CT scan showed discontinuity at the top of the bladder wall and leakage of the contrast agent into the abdominal cavity. Cystoscopy confirmed bladder perforation, leading to a diagnosis of intraperitoneal bladder rupture. Additionally, he habitually engaged in self-injury by injecting carbon dioxide subcutaneously, leading to subcutaneous hematomas and extensive subcutaneous emphysema in the abdomen and back.

Intervention
Post-admission, a urethral catheter was placed, and antibiotic therapy for acute peritonitis was initiated. On the first day of hospitalization, a laparotomy was performed to repair the bladder. The abdominal cavity was contaminated, with a perforation approximately 1.5 cm in diameter observed at the top of the bladder. The perforation was closed, and the abdominal cavity was washed out. Starting from the 8th day of hospitalization, hyperbaric oxygen therapy (HBO2) was administered. Two ATA, 90-minute HBO2, were conducted ten times.

Outcome
On the 21st day, cystography confirmed the absence of urine leakage, and the urethral catheter was removed. After HBO2, the pigmentation of the abdomen due to self-injury tended to fade, and a CT scan showed that the subcutaneous emphysema had completely disappeared. Antibiotic therapy lasted for 14 days, improving the peritonitis. The patient was discharged home on the 22nd day.

Discussion
We report a case of subcutaneous emphysema and intraperitoneal bladder rupture due to self-injurious behavior treated with HBO2. HBO2 possibly accelerated the resolution of subcutaneous emphysema and hematomas and contributed to the promotion of wound healing post-laparotomy. Early surgical intervention, antibiotic treatment, and the addition of HBO2 were considered beneficial for symptom improvement.

F95

ORAL PRESENTATION TIME: n/a
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RESIDENT COMPETITION: No

HBO2 adjunct treatment for HAPE

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Case Description
A 64-year-old male complained of dyspnea and cough after ascent to 2400-2700 meters at Bryce Canyon, Utah. Classic presentation for HAPE with rapid ascent and no acclimation period. Descent to 1800 meters at Garfield Hospital with minimal improvement. Physical examination included oxygen saturation initially of 65% with chest X-ray single view showing pulmonary edema and central vascular congestion. Also had slightly elevated troponin. He was then transferred to SGRH at 800 meters with continued symptoms. Hyperbaric therapy is added as an adjunct to medical care. Noted improvement emesis resolved and continued to ween off oxygen over the next three days and was discharged home. Should hyperbaric therapy be considered if available, and if patients are not improving with decent.

Intervention
The patient received three treatments of hyperbaric @ 2 ATA for 110 minutes with 1 x 5-minute air break. He also received Diamox, Decadron, and Nifedipine after a negative cardiac workup.

Outcome
Resolution of pulmonary edema: discharged home on Lasix and Zofran. Three month follow up he had no residual effects from the event and was getting treatment for sleep apnea.

Discussion
If hyperbaric care is available, should it be considered along the standard of care for patients who may not respond to descent and acclimation?

F96

ORAL PRESENTATION TIME: n/a
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RESIDENT COMPETITION: Yes

Hyperbaric medicine for chronic antibiotic refractory pouchitis: A case study

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Case Description
A 36-year-old female with a history of ulcerative colitis status post total colectomy and ileal pouch-anal anastomosis was complicated by recurrent pouchitis over eight years. Her symptoms manifested as rectal pain/pressure, fecal urgency/incontinence, tenesmus, incomplete evacuation, abdominal pain, nausea, decreased appetite, and poor sleep quality. Care included multiple courses of VSL#3, antibiotics, and steroids. Endoscopic evaluation demonstrated perianal dermatitis, severe cuffitis with ulcers and nodularity, severe pouchitis, inlet ulcers, and 15 cm of pre-pouch ileitis with linear deep ulcers. She was referred to Aurora's Hyperbaric Medicine department, where a compassionate use request was granted secondary to failure of standard medical management.

Intervention
The patient completed hyperbaric oxygen therapy (HBO2) five days per week. Her treatment profile was 2.4 ATA for 90 minutes with two air breaks. Due to equalization difficulty, three treatments were completed at 2.0 ATA with two five-minute air breaks. She completed a total of 39 HBO2.

Outcome
Within 14 HBO2 treatments, stool frequency decreased from >30 stools/day to 10 to 11/day. Fecal incontinence and sleep quality improved. At 29 treatments, peri-anal skin breakdown resolved, and fecal texture improved from soup-like to toothpaste consistency. Other significant improvements included decreased fecal urgency/nausea/fecal incontinence/subjective weight loss and improved appetite/sleep quality. Endoscopic evaluation after 35 HBO2 indicated normal-appearing neo-terminal ileum aside from two small erosions, normal pouch mucosa, no obvious cuffitis, and no inflammation. Improvements plateaued at 39 treatments. Therefore, the HBO2 course was suspended. Benefits were durable at a 2.5-year follow-up.

Discussion
Chronic antibiotic refractory pouchitis occurs in approximately 10% of patients' status post proctocolectomy with ileal pouch-anal anastomosis. Autoimmune effects, microbiome-related issues, inflammatory responses, and ischemia are potential etiologies of pouch failure. This patient's condition was refractory to standard medical care for eight years yet significantly improved with 39 HBO2. The benefits of HBO2 were most likely secondary to ischemia reversal, dampened inflammatory response, and modulation of cellular signaling pathways.

F97

ORAL PRESENTATION TIME: n/a
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RESIDENT COMPETITION: No

Cutaneous chronic graft-versus-host disease successfully treated with hyperbaric oxygen therapy

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Case Description
Graft-versus-host disease develops after an allogeneic hematopoietic cell transplant, where immune cells from a donor cause an immune reaction against a transplant recipient. Cutaneously (cGVHD) include ulcerative, dyspigmented sclerotic plaques. Emollients, topical glucocorticoids, or calcineurin inhibitors are used, often unsuccessfully. When this therapy fails, extracorporeal photopheresis (ECP) is added.

Hyperbaric oxygen (HBO2) has healed cGVHD-related ulcers in a case report and with benefit in animal studies. We present a case of lower leg cGVHD successfully treated with HBO2.

A 67-year-old male with a history of myelofibromatosis status post allogenic hematopoietic stem cell transplantation ten years ago. Severe cGVHD resulted in scleroderma, bilateral leg ulcers, and ischemic changes to his lower legs anteriorly. He had received ECP, oral ruxolitinib, and wound care with Medihoney, Silvadene, and topical tacrolimus. The wounds leaked fluid, and he had refractory leg pain. After months of wound care, along with oncology and dermatology consultation, he was referred for HBO2.

Intervention
The patient completed 100 HBO2 treatments from 4/20/23-10/27/23 with a resolution of his bilateral leg ulcers and the leg pain associated with them. A tacrolimus ointment trial was prescribed but stopped after 20 treatments due to no effect. The patient also used EdemaWear tubular stockinettes to help with local edema. He continues to receive ECP every three weeks with ruxolitinib.

Outcome
His bilateral leg ulcers and leg pain almost resolved. He continues to receive ECP. Nearly four months following HBO2, he had a durable resolution of the ulcers on the right but the persistence of painful ulceration on the left. Another course of HBO2 is ongoing.

Discussion
cGVHD is a difficult condition to treat. A course of HBO2 was almost curative for this patient.

F98

ORAL PRESENTATION TIME: n/a
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RESIDENT COMPETITION: No

Worsening of cutaneous B-Cell lymphoma during a brief course of hyperbaric oxygen therapy

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Case description:
We present a case of a patient with a history of chronic lymphocytic leukemia (CLL) and cutaneous B-cell lymphoma of the right lower leg who has previously received radiation treatments for the area of concern. She developed the stigmata of radiation fibrosis with two non-healing ulcerations at the previous tumor sites. A biopsy of the wound site was performed, which demonstrated spongiotic and sparse superficial perivascular dermatitis but no obvious active cancer. CAR T-cell therapy for her CLL was proposed but was being held due to the presence of open wounds.

Intervention:
She had poorly healing wounds in a previously irradiated area, so adjunctive HBO2 therapy was initiated, and shortly after treatments began, the previous wounds worsened, and multiple new wounds appeared. The hyperbaric therapy was stopped after ten treatments, and she was referred for a biopsy.

Outcome:
Repeat biopsies were performed, and the new areas were deemed consistent with cutaneous large B-cell lymphoma. Chemotherapy/immunotherapy was initiated.

Discussion:
We recommend that patients with a history of active or previously treated cutaneous B-cell lymphoma be closely monitored for any signs of worsening disease if they are to undergo hyperbaric oxygen therapy. If new wounds arise or previous wounds worsen, stop hyperbaric oxygen therapy and refer for biopsy.

F99

ORAL PRESENTATION TIME: n/a
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RESIDENT COMPETITION: No

Acute cardiac autonomic dysfunction following acute carbon monoxide poisoning

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Case Description
We present two previously non-smoking, healthy 38-year-old female fraternal twins with cardiac autonomic dysfunction following acute carbon monoxide (CO) poisoning. The same faulty heating system poisoned both. Both were treated with hyperbaric oxygen. By online searches we could not find publications of cardiac autonomic dysfunction caused by CO poisoning. Online patient forums suggest this can occur after CO poisoning.

With CO poisoning, Twin A lost consciousness and had frontal lobe headaches and nausea. A few weeks after CO poisoning, she developed resting tachycardia, near syncope upon standing with a rapid heart rate, and could no longer work in her prior profession. In addition, she had new debilitating chronic headaches, breathlessness, fatigue, and difficulty multitasking. Echocardiography was normal; her ejection fraction (EF) was 70%. Pulmonary function tests (PFT) showed an increase in diffusing capacity. Positive cardiac tilt table test confirmed diagnosis of POTS.

With CO poisoning, Twin B complained of dizziness, amnesia, and headache. Like her sister, she has continued to have chronic debilitating headaches, fatigue, difficulty multitasking, and inability to work in her prior profession. Echocardiography was normal; her EF was 61%. Her cardiac tilt table test was interpreted as not diagnostic of POTS, only missing the 10-minute criteria by three heartbeats.

Intervention
After hours of poisoning, both twins received $HB0_2$ (3 ATA for 60 minutes with two five-minute air breaks, followed by 2 ATA for 55 minutes with one five-minute air break, time at pressure was 125 minutes and a duration of 150 minutes total; one time.)

Outcome
Both are being treated with metoprolol for cardiac dysfunction without much change.

Discussion
CO poisoning can cause brain and cardiac injury. In this case, it seems that CO poisoning caused cardiac autonomic dysfunction.

F100

ORAL PRESENTATION TIME: n/a
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RESIDENT COMPETITION: No

Human facial canine bite injuries managed with hyperbaric oxygen therapy: A case series

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Case Description
Canine bite injuries represent the most common mammalian bite injury treated emergently, with more than 4.5 million sustained annually in the United States. Half of these events involve children and are associated with physical, emotional, and psychological trauma [1-3]. We report two cases of human facial canine bite injuries managed with prompt irrigation, surgery, antibiotics, and hyperbaric oxygen therapy (HBO2).

Intervention
- Case No. 1: A 22-month-old female sustained a canine bite injury to the left cheek. Primary closure was completed on the day of the presentation. On post-op day (POD) one, a dusky appearance was noted at the central flap tissue. HBO2 was started on POD 2 with two daily sessions completed with 100% oxygen at 2.4 ATA for 105 minutes in a monoplace chamber.
- Case No. 2: A seven-year-old female presented with a canine bite avulsed nasal tip injury. On the day of presentation, the nasal injury was grafted with the avulsed tissue. Eight sessions of HBO2 with 100% oxygen at 2.4 ATA for 105 minutes in a monoplace chamber were started on POD 1 after graft tissue cyanosis was noted.

Outcome
- Case No. 1: The wound healed without complication, and no further surgery was required.
- Case No. 2: She achieved complete healing of the nasal tissues with no tissue loss or further surgery required with good cosmesis.

Discussion
Canine facial injuries typically involve prominences such as the nose, lips, and cheek and can be associated with significant complications. HBO2 is suggested to be beneficial for these types of acute traumas. We report two cases that were successfully managed with the addition of hyperbaric oxygen therapy and had good outcomes. We believe that HBO2 is crucial in the management of human facial canine bite injuries[3-5]. Further research is needed to establish treatment protocols for these acute injuries.

F101

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POSTER PRESENTATION TIME: Sat, Jun 15, 16:30-17:00
RESIDENT COMPETITION: No

Safety of delivering Hyperbaric Oxygen therapy in a patient with Lung transplant: A case report

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Case Description
We present a 58-year-old female who has a history of radiation therapy as a part of multimodal therapy to treat recurrent cutaneous malignancies of the face. She received a total radiation dose of 66 Gy. In addition to the late effects of radiation, surgical intervention was pursued in this previously irradiated field, including reconstruction using a free flap. Hyperbaric oxygen therapy (HBO2) was requested to help manage the delayed effects of radiation and to ensure the viability of the free flap.

Past medical history was significant for a bilateral lung transplant over 20 years ago for pulmonary hypertension and a subsequent right single lung transplantation approximately five years later for chronic rejection of the initial lung transplant. Given this extensive past medical history, there was concern regarding pulmonary adverse effects of HBO2.

Intervention
Pulmonary consultation was sought. Based on a review of the literature and expert opinion, cautious clearance for HBO2 was given. The patient explained the benefits and risks, and she agreed to proceed.

Outcome
She completed seven treatments (2 ATA) at our facility without any complications and completed further sessions at a local Hyperbaric Medicine facility. At last contact, she was doing well without any complications that could be attributed to HBO2.

Discussion
Hyperbaric oxygen therapy is associated with pulmonary adverse effects, including pulmonary barotrauma and pulmonary oxygen toxicity. These risks are enhanced in the setting of thoracic surgery and other pulmonary diagnoses. Our case highlights the fact that even with extensive thoracic surgery history, especially pulmonary transplant, HBO2 may be delivered safely with adequate precautions and prior evaluation. There are small retrospective studies as well as case series involving patients with lung transplants who have undergone Hyperbaric oxygen therapy without significant pulmonary adverse effects.

F102

ORAL PRESENTATION TIME: n/a
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Treatment of cricoid chondronecrosis using an unconventional combination of hyperbaric oxygen therapy, tracheostomy and antibiotics

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Case Description
Chondronecrosis of the cricoid is a rare and life-threatening clinical entity most often associated with mucosal and subsequent cartilage injury after intubation (prolonged or traumatic). Avascular necrosis of the cricoid may result in localized swelling, fluid collection, infection/abscess, and ultimately subglottic airway obstruction. Tracheostomy is a well-established fail-safe when presented with impending airway compromise due to upper airway obstruction. After establishing a secure airway, steroids and antibiotics are generally used to decrease swelling and treat any underlying infection. Hyperbaric oxygen therapy (HBO2) is rarely prescribed for adjunctive treatment for chondronecrosis of the cricoid.

Intervention
Two cases of cricoid chondronecrosis were treated with hyperbaric oxygen. Both presented with biphasic stridor and dyspnea several weeks after an intubation event. Both patients were administered high-dose steroids and underwent awake tracheostomy. Seven days of IV levofloxacin was completed and 20-30 HBO2 treatments of 90 minutes at 2.5 atmospheres absolute. This was modeled after generally accepted current treatment regimens for similar diagnoses.

Outcome
Both patients were decannulated within six months of presentation and after at least 20 HBO2 therapy sessions. Flexible laryngoscopy at the time of decannulation confirmed resolution of post-cricoid edema, healthy-appearing vocal folds with improved though still somewhat restricted abduction, and full adduction with complete glottic closure in one.

Discussion
Our results are consistent with data supporting HBO2's effects on tissue edema, neovascularization, and HBO2 potentiation of antibiotic treatment and leukocyte function. We suggest HBO2 therapy may have accelerated airway decannulation by way of infection resolution and the revitalization of upper airway tissues, ultimately renewing the structural integrity of the larynx. When presented with this rare but significant clinical challenge, physicians should be aware of the potential benefits of HBO2 therapy.

F103

ORAL PRESENTATION TIME: n/a
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RESIDENT COMPETITION: Yes

Hyperbaric oxygen therapy for portal venous gas embolism following hydrogen peroxide ingestion

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Case Description

Hydrogen peroxide (H_2O_2) ingestion is known to cause gastric irritation, nausea, and emesis. Consumption of H_2O_2 has also been demonstrated to produce in vivo gas bubbles, leading to gas embolism (GE) formation and potentially devastating side effects. While most reported cases of GE secondary to H_2O_2 ingestion involve the intake of industrial grade concentrate solutions (>35%), household intoxications have limited reporting. In this case, we report a middle-aged patient who presented to the emergency department after having developed a GE secondary to the ingestion of household grade hydrogen peroxide (typically 3%). Her initial complaints were of severe gastric pain, nausea, and vomiting. She also required single in/out catheterization to void her bladder, concerning for neurological symptom of urinary retention.

Intervention

CT imaging of her abdomen demonstrated substantial portal venous gas as well as pneumatosis recti. After discussion with Poison Control service, recommendation was made for Hyperbaric Oxygen therapy (HBOT), prompting transfer to a regional center with 24/7 HBOT. Treatment was given on US Navy Treatment Table 6 due to the severity of the patient's presentation and gas load.

Outcome

After one round of hyperbaric oxygen treatment, the patient's venous gas load had been reduced dramatically, visualized on repeat CT scan. Additional hyperbaric oxygen treatment was considered given initial severity. However, at the time of re-evaluation, the patient was declining any further medical care. After consideration of clinical improvement and patient's wishes, it was decided that the patient did not require further emergent treatment.

Discussion

This case demonstrates, in conjunction with known literature, that HBOT can be used to successfully treat gas emboli associated with H_2O_2 consumption. From this, we recommend the consideration of HBOT in any case of significant H_2O_2 ingestion in a clinical presentation that is compatible with gas emboli.

F104

ORAL PRESENTATION TIME: n/a
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RESIDENT COMPETITION: Yes

Alcohol intoxication vs decompression sickness

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Case Description
A 36-year-old male commercial diver was intoxicated and arrested for DUI after failure to perform a breathalyzer. He was taken to the hospital for serum alcohol level. In the emergency department, he claimed that his symptoms of headache, sinus pressure, bloody sputum, numbness in lips, unsteady gait, and vertigo were due to decompression sickness. His serum alcohol level was 179 g/dl (Normal

Intervention
To err on the side of caution, he was treated with a US Navy treatment table 6 without extensions or tailing treatments.

Outcome
His symptoms of headache and vertigo resolved within the first 10 minutes of reaching the target pressure, and his post-treatment neuro exam did not reveal any deficits.

Discussion
Alcohol intoxication and some mild cases of DCS can present with similar symptoms, which can make it difficult for physicians to make an accurate diagnosis. Since the patient's symptoms resolved during and after the treatment, it is easy to say that his symptoms were due to DCS. Especially since he has the potential risk for the injury and was also presenting with other dive-related injuries (reverse-sinus squeeze). However, due to the scarcity of evidence on the effects of hyperbaric oxygen on acute alcohol intoxication and veisalgia, one cannot rule out these as potential causes of his symptoms. Further studies would need to be performed on the effects of HBO2 on patients with acute alcohol intoxication and/or veisalgia in order to better understand if those ailments can be treated with HBO2.

F105

ORAL PRESENTATION TIME: n/a
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Patient suffering Guillain Barré Syndrome mimicking Neurological Decompression Syndrome

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Case Description
This is the case of a 28-year-old male fisherman diver, evaluated in the Hyperbaric Medicine Department at the Puerto Rico Medical Center, San Juan, Puerto Rico, who came complaining of neurological symptoms that presented 24 hours after five days of continuous multiple dives within no decompression limits. A diagnosis of suspected decompression syndrome was made at that time, and physical and neurological evaluation for the diving accident was performed. The patient referred a history of an episode of fever, muscle pain, and diarrheas a week before the symptoms appeared, which resolved spontaneously. A provisional diagnosis of neurological DCS was made, and an emergency hyperbaric oxygen treatment was prescribed.

Intervention
USN Treatment Table 6. Post-treatment evaluation showed the persistence of the neurological deficit and that the deep tendon reflexes were absent. In a more in-depth interview with the patient and his mother, they mentioned he had been having double vision and weakness with ascending tingling sensations from feet to upper body for the previous five days. The neurology service was consulted for evaluation of a possible Guillain-Barre syndrome.

Outcome
Based on the history, clinical data, and unresponsiveness to hyperbaric therapy, a diagnosis of neurological decompression syndrome was excluded, and no more hyperbaric treatment was recommended. The patient was admitted to the hospital by the neurology service with a diagnosis of Guillain Barré syndrome, Miller Fisher variant. Immunoglobulin therapy was started the same day with an excellent response. He was discharged home with mild ophthalmoplegia and mild ataxia.

Discussion
The importance of proper history, repetitive physical and neurologic exams, and continuous case reassessment and evaluation after a lack of response to hyperbaric oxygen therapy leads to considering another diagnosis, such as Miller Fisher syndrome, a variant of Guillain Barré polyneuritis. These contribute to excluding a DCS as a working diagnosis with no indication for additional hyperbaric treatment.

F106

ORAL PRESENTATION TIME: n/a
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RESIDENT COMPETITION: No

Re-entrant ventricular tachycardia needing ablation after carbon monoxide poisoning

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Case Description
A 16-year-old male, previously healthy, active, and with a negative family history of cardiovascular disease, was poisoned by carbon monoxide (CO) from a faulty home heating system. He had felt poorly for several days. He was taken to an Emergency Department (ED), where he was provided oxygen, but CO poisoning was not suspected. On the way home, his brother, still at home, had lost consciousness. Responding EMTs recognized CO poisoning. Both were transported to the ED. The 16-year-old's carboxyhemoglobin was 27%. His ECG and troponin I were normal. He did not receive hyperbaric oxygen. In the weeks to months following, he developed episodic chest pain, palpitations, and syncope. He described suddenly feeling his heart racing, light-headed, then passed out, or nearly so. This occurred every few days. Stress echocardiography was normal. The ambulatory telemetry monitor was initially interpreted as normal with isolated premature ventricular complexes (PVCs). Local clinicians felt this was psychogenic. After referral to our facility, the adenosine stress cardiac MRI was normal. Subsequent interpretation and additional telemetry data that showed an augmented PVC burden – electrophysiologic (EP) study was recommended. Fourteen months after CO poisoning, he had an EP study. At baseline, he had frequent PVCs that augmented to couplets, triplets, and ventricular tachycardia (VT) runs in the presence of isoproterenol. Activation mapping localized the arrhythmia to the right ventricular outflow tract (RVOT), just inferior to the pulmonic value where successful ablation was performed.

Intervention
With a separate procedure, he had radiofrequency ablation of an RVOT ventricular arrhythmia.

Outcome
Ablation therapy was effective. Over the next six years, he had no similar events.

Discussion
This case represents a patient with symptomatic triggered catecholamine-sensitive VT in a structurally normal heart, likely caused by carbon monoxide poisoning, despite an initial negative ECG and troponin I at the time of CO poisoning.

F109

ORAL PRESENTATION TIME: n/a
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RESIDENT COMPETITION: Yes

Compartment Syndrome Neuropathy Resolution with Hyperbaric Oxygen

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Case Description
A 13-year-old female gymnast and ballet dancer suffered left leg pain after particularly strenuous back to-back workouts in these two activities. After a few hours the pain remitted, but the patient had a residual peroneal nerve palsy (i.e., drop foot gait). For the drop foot gait problem, she presented to an emergency department two days after the activity. A skeletal muscle-compartment syndrome (SMCS) was suspected. However, compartment pressure measurements were normal at that time. She was advised to seek orthopedic evaluation for managing the peroneal nerve palsy.

Intervention
This was so obtained four days after the inciting event. The orthopedist who was knowledgeable about hyperbaric oxygen therapy advised a hyperbaric oxygen treatment for the diagnoses of combined exertional compartment (now asymptomatic) plus a SMCS component as the cause of the peroneal palsy. Shortly thereafter the patient was given a hyperbaric oxygen treatment (2 ATA for 90 minutes).

Outcome
The patient walked into the hyperbaric oxygen facility with a steppage gait otherwise asymptomatic. While undergoing the treatment she was witnessed being able to actively dorsiflex her left ankle. After the treatment was completed, she departed the hyperbaric facility walking with a normal gait and was able to resume her gymnast and ballet activities. However, she continued to experience exertional related pain with the activities.

Discussion
The literature reports that a neuropathy associated with a SMCS only has a 10-percent chance of resolving after fasciotomy. The temporal relationships and outcome of this case strongly suggest that the hyperbaric oxygen treatment resolved the neuropathy problem. The patient's clinical presentation and course were consistent with an exertional compartment syndrome where pain resolves spontaneously usually within minutes or hours after the activity and a full-blown SMCS where nerve injury and/or muscle damage can persist even after a fasciotomy.

F110

ORAL PRESENTATION TIME: n/a
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RESIDENT COMPETITION: No

Hyperbaric Oxygen for Long-Covid Syndrome, Part II

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Case Description:
48-year-old business-legal professional, previously physically healthy and fit, was infected with SARS–CoV–2 (antigen+PCR testing, October 2021); developed COVID-pneumonia; then presented with Long-COVID Syndrome, including symptoms of brain fog/fatigue; bodily fatigue; head pain, with sensitivity to light and sound; tinnitus; tremors, starting in the hands and fingers; then nerve pain in the legs, usually after ~1 hour from the onset of tremors, most evenings and into the night. In time, friends and family noticed changes in the patient's personality and temperament—symptoms of PTSD and bipolar disorder. Eventually, the patient participated in the AVIV Medical Program.

Intervention:
The previously published intervention is included in the 2023 UHMS Annual Science Meeting Abstracts.[1] In the relevant part, the patient underwent hyperbaric oxygen therapy (HBO2) under the Tel Aviv protocol: 2.0 ATA x 90 minutes x 60 sessions, once per weekday, for twelve weeks. During the HBO2 sessions, the patient also engaged in neurocognitive training that targeted injured areas of his brain. This case study answers whether the intervention was successful long-term, i.e., approximately nine months after the patient's last HBO2 session in January 2023.

Outcome:
Neurocognitive testing and cardiopulmonary testing in late September 2023 showed that the patient was able to maintain the gains measured after the twelve-week medical program. Further, advanced brain imaging in September 2023 demonstrated that HBO2, under the Tel Aviv protocol, was highly effective in repairing patient's brain injuries diagnosed before the Medical Program.

Discussion:
The results of the case study support and are consistent with peer-reviewed articles that demonstrate how HBO2 under the Tel Aviv protocol, i.e., using the hyperoxic-hypoxic paradox, improves neuroplasticity, including stem cell proliferation, biogenesis, and angiogenesis.

References

[1]White, J. Hyperbaric oxygen for long COVID condition. *Undersea Hyperb Med.* 2023 Second Quarter; 50(2) 197–198.

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Save the dates

Future Annual Meeting Dates & Locations

June 1-6, 2025

HYATT REGENCY ATLANTA, GA

This meeting will be a combined meeting with Aerospace Medical Association.

AsMA workshops / UHMS pre-courses: Sunday, June 1
AsMA/ASM General Session-Breakouts: Mon-Thurs: June 2-5
AsMA post-course: Friday: June 6

2024 CHAPTER TOWN HALL MEETINGS

- PACIFIC CHAPTER: August 10
  - Topic: Clinical Hyperbaric Medicine
- NORTHEAST CHAPTER: October 12
  - Topic: Safety

2025 CHAPTER TOWN HALL MEETINGS (dates subject to change)

- GULF COAST CHAPTER: March 1
  - Topic: Diving
- MID-WEST CHAPTER: May 3 or 10
  - Topic: Clinical Hyperbaric Medicine
- PACIFIC CHAPTER: August 9
  - Topic: Safety
- NORTHEAST CHAPTER: October 11
  - Topic: Wound Care

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