Undersea & Hyperbaric Medical Society

2014 ANNUAL SCIENTIFIC MEETING

Program & Abstracts

June 19-21

Hyatt Regency at the St. Louis Arch

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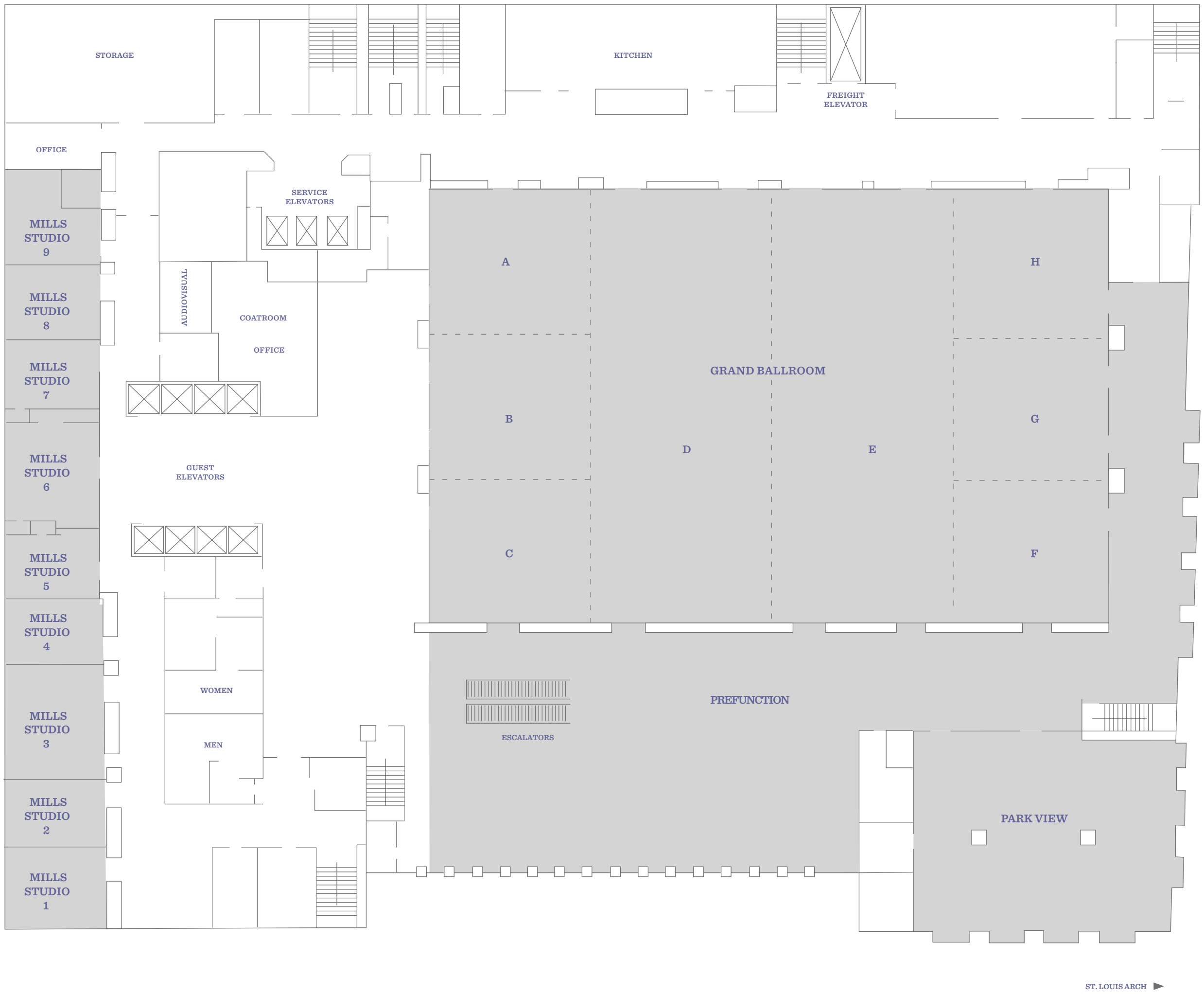

2014
UHMS Scientific Meeting

June 19-21

St. Louis, Missouri

General Session: Grand Ballroom E-H
Poster Session: Grand Ballroom Foyer
Exhibits / Breaks: Grand Ballroom D
Associate Breakout (Thursday): Grand Ballroom B&C

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Undersea & Hyperbaric Medical Society
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Southern African Underwater & Hyperbaric Medical Association (SAUHMA)
South Pacific Underwater Medicine Society (SPUMS)

SCHEDULE

O: Oral Presentation
P: Poster Presentation

General Session: Thursday, June 19: 8am – 6:45pm			**Grand E-H**
0700 – 0800		**Continental Breakfast / Exhibits**	**Grand D**
0800 – 0830		**President's Address**	**John Feldmeier, DO, FUHM**
0830 – 1745		**Associate Breakout Session**	**Grand B-C**
0830 – 09300		**Plenary Session: Update on Clinical Practice Guidelines in Hyperbaric Medicine**	**Enoch Huang, MD, FUHM & Jaleh Mansouri, MD**
0930 – 1000		**Break / Exhibits**	**Grand D**
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O: 1100 - 1112 P: 1130 - 1200	A6	NAVSEA 2 Cognitive Testing At HIGH Workload Levels Improves Performance Discrimination On The Multi-Attribute Task Battery-II	Viola JH, Derrick BJ, Cobb T, Natoli MJ, Schinazi EA, Martina SD, Qin M, Medford M, Scafetta N, Moon RE, Freiberger JJ
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1200 – 1315		**LUNCH**	**On Own**

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1745 – 1845		**Meeting your Exhibitor “Wine & Cheese Reception”**	**Grand D**
General Session: Friday, June 20: 8am-5pm			**Grand E-H**
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P: 0900 - 0930		Of Hyperbaric Oxygen (HBO_2) For Persistent Post-Concussive Symptoms After Mild Traumatic Brain Injury (BIMA) Study	Lindblad AS, Churchill S, Wilson SH
O: 0800 - 0812 P: 0900 - 0930	C27	Neurological Evaluations Within The Brain Injury And Mechanisms Of Action Of Hyperbaric Oxygen (HBO_2) For Persistent Post-Concussive Symptoms After Mild Traumatic Brain Injury (mTBI) Study (BIMA)	Williams C, Weaver LW, Lindblad AS, Wierzbicki MR, Langford D
O: 0800 - 0812 P: 0900 - 0930	C28	Characterization Of Baseline EEG Abnormalities In The Brain Injury And Mechanisms Of Action Of Hyperbaric Oxygen (HBO_2) For Persistent Post-Concussive Symptoms After Mild Traumatic Brain Injury (mTBI) Study (BIMA)	Spitz M, Williams C, Foley JF, Weaver LW, Lindblad AS, Wierzbicki MR
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O: 0836 - 0848 P: 0900 - 0930	C32	Phase 2 Clinical Trial Using Hyperbaric Oxygen, Radiation And Chemotherapy For Glioblastoma Treatment	Duic JP, Grewal J, Gorenstein S, Haas J, Demaria T, Tessler L, Rak R, Almaliah M, McConie K, Prabhu RK, Trojanowski J, Namoca M
O: 0848 - 0900 P: 0900 - 0930	C33	TNF-Alpha As A Biomarker For Neurological Severity In Acute Carbon Monoxide (CO) Poisoning	Vezzani G, Abbati E, Caberti L, Cantadori L, Galli E, Manelli D, Mordacci M, Reverberi C, Spigolon A, Malpeli M, Dazzi D, Pizzola A, Mangar D, Camporesi EM
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O: 1024 - 1036 P: 0900 - 0930	C36	Delayed Visual Disturbances In Carbon Monoxide Poisoning: Identification And Evaluation	Stabile J, Weaver LK, Deru K, Price R
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O: P: 0900 - 0930	C43	Hyperbaric Oxygen Therapy For Prevention Of Sickle Cell Vaso-Occlusive Episodes	Chambers P, Heyboer M, Jennings S, Mariani P, Morgan M, Sills R, Elfar M, Santiago W
O: P: 0900 - 0930	C44	Hyperbaric Oxygen For Avascular Necrosis Of The Femoral Head: A Case Study	Martin C, Morgan M, Santiago W, Jennings S, Mariani P, Heyboer M
O: P: 0900 - 0930	C45	Hyperbaric Oxygen Treatment For Post-Radiation Central Nervous System Injury: A Retrospective Case Series	Valadão J, Pearl J, Verma S, Helms A, Whelan HT
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1200 - 1330		**Special Meeting: "HBO_2 Reimbursement and Regulatory Update" (Non CME/CEU – Lunch is not included) All welcome**	**Helen Gelly, MD, FUHM Enoch Huang, MD, FUHM Caroline Fife, MD, FUHM**
1200 - 1330		**LUNCH**	**On Own**
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P: 1530 - 1600		Closed-Circuit Rebreather Trimix Diving	Wiley JM, Pollock NW
1600 – 1700		**Plenary Session: Reflections on The Neurotherapeutic Effects of Hyperbaric Oxygen**	**Shai Efrati, MD**
1700 – 1800		**UHMS Annual Business Meeting**	**Grand E-H**
1900 - 2200		**UHMS Awards Banquet (additional fee required)**	**Grand A-C**
General Session: Saturday, June 21: 8am-5:30pm			**Grand E-H**
0700 – 0800		**Continental Breakfast / Exhibits**	**Grand D**
0800 – 0930		**Plenary Session: International Perspectives on Hyperbaric Oxygen**	**Ken LeDez, MD & Panel**
SESSION E: HBO_2 Therapy, Chambers and Equipment			
0930 – 1000		**Break / Exhibits**	**Grand D**
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O: 1024 - 1036 P: 1130 - 1200	E75	Adjustable Lens Eyeglasses For Visual Changes Associated With Hyperbaric Oxygen Treatment	Ptak J, Toutain-Kidd C, MacKenzie G, Zegans M, Buckey J
O: 1036 - 1048 P: 1130 - 1200	E76	Hyperbaric Oxygen (HBO_2) In Patients With Delayed Ventilation	Moffat AD, Churchill S, Deru K, Weaver LK
O: 1012-1024 P: 1130 - 1200	E77	Hyperbaric Oxygen Therapy For The Critically Ill: How Safe Is It?	Lo T, Song C, Alismail A, Terry MH, Bland D
O: 1100 - 1112 P: 1130 - 1200	E78	Quality Assurance: Evidence Of Effect	Wagner T
O: 1112 - 1124 P: 1130 - 1200	E79	Centers Capable Of Treating Hyperbaric Emergencies In The United States	Chin W, Jacoby L, Talati N, Jacoby R, Millbern C, Wegrzyn G, Sprau S
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O: P: 1130 - 1200	E98	Capnograph Testing And Comparison At Treatment Pressure Within The Multiplace	Fuqua WR, Narr T, Gossett W, Claus PL
O: P: 1130 - 1200	E99	Hooked On Hookah: Severe Carbon Monoxide Poisoning In Water-Pipe Users	Medford MA, Moffat A, Hexdall E, Stabile J, Moon RE
O: P: 1130 – 1200	E116	HBO in radiation-induced cystitis and proctitis: Two-year follow-up of a prospective cohort study on patient-perceived quality of recovery	Oscarsson N, Arnell P, Lodding P, Ricksten SE, Seeman-Lodding H
1200 – 1330		**Lunch**	**On Own**
1330 – 1430		**Plenary Session: New Pearls of Wisdom in the Diving and Hyperbaric Medicine Literature**	**Marlon Medford, MD** **Manish Mehta, MD**
SESSION F: Diving Equipment and Decompression Illness			
O: 1442 - 1454 P: 1630 - 1700	F100	The Significance Of Noise Exposure Of Divers During Typical Diving Operations In The Norwegian Sector Of The North Sea	Nedwell JR, Mason TI, Collett AG, Gardiner RWK
O: 1454 - 1506 P: 1630 - 1700	F101	Diving Into The Heart Of Trouble: Cardiac Health Of UK Sport Divers	St Leger Dowse M, Cridge CEL, Waterman MK, Smerdon G
O: 1506 - 1518 P: 1630 - 1700	F102	Unrecognized Decompression Sickness Among Breath-Holding Pearl Divers In The Arabian Gulf	Bergson M, Dennis R, Sulaiman N, Ferrigno M, Connor C
O: 1518 - 1530 P: 1630 - 1700	F103	CO And CO_2 Analysis In The Diving Gas Of The Fishermen Of The Yucatan Peninsula	Chin W, Huchim O, Wegrzyn G, Sprau S
O: 1530 - 1542 P: 1630 - 1700	F104	Modeling Carbon Monoxide Reduction In A Single Compressor Hookah Dive System	Chin W

O: 1542 - 1554 P: 1630 - 1700	F105	Reducing Carbon Monoxide Content In Surface-Supplied (Hookah) Air Sources Of Artisanal Fishermen Of The Yucatan Peninsula	Chin W, Wegrzyn G, Millbern C, Jacoby R, Talati N, Sprau S
O: 1554 - 1606 P: 1630 - 1700	F106	Divers With Implantable Cardiac Devices: Clinical Characteristics And Variations In Diving Practice	Bourque JM, Ranapurwala SI, Denoble PJ
1606 – 1630		**Break / Exhibits**	**Grand D**
O: P: 1630 - 1700	F107	Brain Damage In Commercial Breath-Hold Divers	Kohshi K, Tamaki H, Lemaitre F, Okudera T, Ishitake T
O: P: 1630 - 1700	F108	Proposal For A New Decompression Illness (DCI) Severity Classification Based On 98 DCI Clinical Cases And Outcomes.	Kojima Y, Enomoto M, Togawa S, Oyaizu T, Horie M, Yagishita K
O: P: 1630 - 1700	F109	A Case Of Intrahepatic Portal Venous Gas With Systematic Gas Findings By CT In Decompression Illness	Oyaizu T, Yagishita K
O: P: 1630 - 1700	F111	The Importance Of Appropriate Treatment Table Use In Commercial Diving Decompression Sickness	Ulloa J, Buford K, Murphy-Lavoie H, LeGros TL, Harch P
O: P: 1630 - 1700	F112	Commercial Diving Injuries: The Psychosocial And Economic Factors That Challenge The Appropriate Management	Murillo IF, LeGros TL, Murphy-Lavoie H, Buford K, Wyatt HA
O: P: 1630 - 1700	F113	Chronic DCI Cognitive Dysfunction Improved With Hyperbaric Oxygen: A Case Report	Wolf EG, Flower AM, Richards MF, Bradley KR, Beckstrand DP, Krassow JL
Will be presented during Session D	F114	Pulmonary Function Response To Recreational-Technical Closed-Circuit Rebreather Trimix Diving	Clarke NW, Mackey MN, Wiley JM, Pollock NW
O: P: 1630 - 1700	F115	The "Skin Bends" Hypothesis: Do Extravascular Bubbles Cause "Skin Bends?"	Vann RD
1700 – 1730		**President's Awards**	**Grand E-H**

MEETING SCHEDULE

Mills 1	Mills 2	Mills 3	Mills 4	Mills 5	Mills 6

Tuesday, June 17		
4:00pm-11pm	UHMS Board of Directors Meeting	Mills 3
Wednesday, June 18		
4pm-6pm	Hyperbaric Oxygen Therapy Committee	Mills 1
2:30pm-3:30pm	Membership Committee	Mills 2
5pm-7pm	Associate Council	Mills 2
1pm-4:00pm	ABPM EXAM	Mills 3
3:30pm-4:30pm	Publication Committee	Mills 4
1pm-2:30pm	CHT Study Hall (1-3)	Mills 5
2:30pm-3:30pm	CHT Study Hall/Exam (3:30-)	Mills 5
4pm-6pm	CHT Exam	Mills 5
4pm-6pm	BNA Board Meeting	Mills 6
Thursday, June 19		
7am-8am	Safety Committee Meeting	Mills 2
6pm-8pm	Accreditation Council	Mills 2
12pm-1pm	CPG Reviewers Meeting	Mills 3
3pm-5pm	Education Committee	Mills 3
12pm-1:15pm	Associate Business Luncheon	Mills 4
6:45pm-8pm	BNA General Meeting	Mills 6
12:00-12:30pm	Special Meeting: "Office of Naval Research Undersea Medicine Program, A Natinal Naval Responsibilty"	Grand E-H
Friday, June 20		
7am-8am	Past President's Breakfast	Mills 1
8am-11am	NBDHMT Board Breakfast	Mill 2
8am-11am	NBDHMT Board Meeting	Mills 3
12:00-12:30pm	Special Meeting: "HBO_2 Reimbursement and Regulatory Update"	Grand E-H
5pm-6pm	UHMS Annual Business Meeting	Grand E-H
1pm-5pm	LeGros/Alleman: Safety subcommittee work group	Mills 5
Saturday, June 21		
12:30-1:30pm	Journal CME Meeting	Mills 2
Sunday, June 22		
8am-5pm	Accreditation Survey Training (contact Tom Workman for more information)	Parkview

SOCIAL FUNCTIONS

WEDNESDAY, JUNE 18			
7:00pm	9:00pm	Welcome Reception	Parkview
THURSDAY, JUNE 19			
5:45pm	6:45pm	Meet the Exhibitors "Wine & Cheese Reception"	Grand Ballroom D
FRIDAY, JUNE 20			
7:00pm	10:00pm	Awards Banquet	Grand Ballroom A-C

ASSOCIATES BREAKOUT SESSION

0830-0840	WELCOME	Kip Posey
0840-0850	E75: Adjustable Lens Eyeglasses For Visual Changes Associated With Hyperbaric Oxygen Treatment	Judy Ptak
0850-0900	C54: Iatrogenic Cerebral Gas Embolism Successfully Treated With Hyperbaric Oxygen Therapy.	Annette Gwilliam
0900-0910	C48: Hyperbaric Oxygen Treatments For Improving Stump Salvage After Above The Knee Amputation In Patients With Severe Unreconstructable Vascular Disease	Judy Ptak
0910-0920	C47: HBOT For Delayed-Radiation Injury Secondary To Fluoroscopy In Patient With A Non-Healing Back Wound	Suzanne S. Clark
0920-0930	E84: Educating Hyperbaric Staff About Common Diabetic Medications And Their Potential To Increase Risk Of Hyperglycemia In Diabetic Patients Undergoing Hyperbaric Oxygen Treatments.	Janet H Bello
0930-0940	E80: Reducing The Risk Of Hyperbaric-Induced Hypoglycemia Seizure Activity	James R. Wilcox
0940-0950	D71: Seizure Following Hyperbaric Treatment For Decompression Sickness	Diana Bodwin
0950-1000	E91: Ventilator Testing In A Multiplace Hyperbaric Chamber	Walter Chin
1000-1030	BREAK / EXHIBITS	GRAND D
1030-1040	E92: Patient Grounding Validation In Monoplace Chambers	James Bell
1040-1050	E83: The O'Neill Grading System For Evaluationof The Tympanic Membrane / A Practical Approach For Clinical Hyperbaric Patients	Erica Weitzner
1050-1100	E78: Quality Assurance: Evidence Of Effect	Tamar Wagner
1100-1110	E74: Lateral Application To Accelerating Patient Flow In The Hyperbaric Chamber	Brett Leis
1110-1120	E87: Evolution Of Nurse Practitioners In Hyperbaric Medicine	Camellia Gwen Gatlin
1120-1130	E97: Analysis Of EMMA End Tidal CO2 Under Increase Barometric Pressure	Gracelene Wegrzyn
1130-1140	C55: Benefits Of Epidermal Harvesting For Wound Closure	Annette Gwilliam
1140-1150	E95: Alcohol-Impregnated Port Protectors: A New Potential Risk For Hyperbaric Chambers	Susan Dunn
1150-1200	E94: Incidence Of Middle-Ear Barotrauma With Hyperbaric Oxygen Therapy	Gail Wilson
1200-1315	LUNCH (Associate Luncheon: 12-1:00 Parkview / Business Meeting: 1:00 – 1:15: Parkview)	ON OWN
1315-1415	LAMBERTSEN LECTURE: *To the Very Depth: Dr. Peter Bennett*	GRAND E-H
1415-1425	E79: Centers Capable Of Treating Hyperbaric Emergencies In The United States	Walter Chin
1425-1435	E98: Capnograph Testing And Comparison At Treatment Pressure Within The Multiplace	William R. Fuqua
1435-1445	F114: Pulmonary Function Response To Recreational-Technical Closed-Circuit Rebreather Trimix Diving	Niles Clarke
1445-1455	F104: Modeling Carbon Monoxide Reduction In A Single Compressor Hookah Dive System	Walter Chin
1455-1505	A9: Perfusion-Diffusion Gas Content Compartmental Models As A Precitor Of Decompression Sickness	F Gregory Murphy
1505-1515	D60: Divers Alert Network Fatality Database Review For Breathing Gas Contamination: 2004-2012	Brittany Trout
1515-1525	D61: Triathlon Deaths: Swimming-Induced Pulmonary Edema?	Stefanie D. Martina
1525-1600	BREAK / EXHIBITS	GRAND D
1600-1610	F105: Reducing Carbon Monoxide Content In Surface-Supplied (Hookah) Air Sources Of Artisanal Fishermen Of The Yucatan Peninsula	Walter Chin
1610-1620	F101: Diving Into The Heart Of Trouble: Cardiac Health Of UK Sport Divers	Marguerite St Leger Dowse
1620-1630	E93: Evaluation Of The Nova Biomedical Statstrip Glucose Xpress For Use In The Multiplace Chamber	James Bell
1630-1640	D62: Efficacy Of The U.S. Navy Dive Tables In Treating DCS In 103 Recreational SCUBA Divers	Walter Chin
1640-1650	F103: CO And CO2 Analysis In The Diving Gas Of The Fishermen Of The Yucatan Peninsula	Walter Chin
1650-1700	A10: Depth Scaling Of Several Gas Super-Saturation Decompression Models	Ethan Hada
1700-1730	UHMS Looks to the Future	John Peters

Disclosures

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James Holm, MD, Seattle, WA	Guy Dear, MB FRCA: Durham, NC	John Feldmeier, DO, Toledo, OH
Claude Piantadosi, MD, Durham, NC	Enoch Huang, MD, Portland, OR	Laurie Gesell, MD, Brookfield, WI
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Faculty/Moderators:

The following faculty/moderators had no relevant financial relationships with commercial interests to disclose

John Feldmeier, DO, FUHM	Enoch Huang, MD, FUHM	Jaleh Mansouri, MD
Peter Bennett, PhD, DSc, FUHM	Michael Bennett, MD, FUHM	Neil Hampson, MD, FUHM
Shai Efrati, MD	Ken LeDez, MD	Marlon Medford, MD
Manish Mehta, MD		

The following presenters had no relevant financial relationships with commercial interests to disclose

A1: Fothergill DM, Florian JP, Shykoff BE; **A2:** Thom SR, Bhopale VM, Yang M; **A4:** Tatar S, Arican N, Orhan N, Yılmaz CU, Ahishali B, Kaya M, Toklu AS; **A5:** emchenko IT, Gasier H, Allen BW, Piantadosi CA; **A6:** Viola JH, Derrick BJ, Cobb T, Natoli MJ, Schinazi EA, Martina SD, Qin M, Medford M, Scafetta N, Moon RE, Freiberger JJ; **A7:** Derrick BJ, Cobb T, Natoli MJ, Schinazi EA, Martina SD, Qin M, Viola JH, Medford M, Scafetta N, Moon RE, Freiberger JJ; **A9:** Murphy FG, Hada EA, Doolette DJ, Howle LE; **A10:** Hada EA, Howle LE, Murphy FG; **A12:** Huang G, He CY, Xu JJ, Xu WG; **B13:** Heyboer M, Milovanova TN, Wojcik S, Grant W, Chin M, Hardy KR, Lambert DS, Logue C, Thom SR; **B14:** Xu J, Huang G, Zhang K, Sun J, Xu T, Li R, Tao H, Xu W; **B15:** Gasier HG, Demchenko IT, Piantadosi CA; **B16:** Gasier HG, Demchenko IT, Kraft BD, Suliman HB, Piantadosi CA; **B17:** Wilkinson DC, Nolting M, Mahadi MK, Chapman IM, Heilbronn LK; **B18:** Medford MA, Kraft BD, Ulrich AM, Suliman HB, Piantadosi CA; 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**C34:** Eggert J, Worth ER, VanGils C; **C35:** Moffat AD, Worth ER, Weaver LK; **C36:** Stabile J, Weaver LK, Deru K, Price R; **C37:** Moffat AD, Foley JF, Deru K, Weaver LK; **C38:** Hampson NB, Dunn SL, and Members of the UHMS Carbon Monoxide Surveillance Program; **C39:** Hampson NB, Courtney TG, Holm JR; **C40:** Walter J, Westgard B; **C41:** Kosugi K, Yamaguchi T, Miyata K, Takao K, Tamura H, Kawashima M, Kawashima M; **C42:** Ptak J, Hartford A, Buckey J; **C43:** Chambers P, Heyboer M, Jennings S, Mariani P, Morgan M, Sills R, Elfar M, Santiago W; **C44:** Martin C, Morgan M, Santiago W, Jennings S, Mariani P, Heyboer M; **C45:** Valadão J, Pearl J, Verma S, Helms A, Whelan HT; **C46:** Moffat AD, Weaver LK, Tettelbach WH; **C47:** Clark SS; **C48:** Ptak J, Walsh D, Buckey J; **C49:** Lo T, Song C, Clevenger S, Bland D; **C50:** Hendriksen SM, Logue CJ, Hardy KR, Lambert DS; **C51:** Yang BW, Levine J, Chacko B, Maurais S, Friedman H, Hurst S, Singh B, Ouseph J, Kurunathapillai K, Saeed M, Selvaraj S, Goumas W, Liberis G, Rosas D, Hurst S, Qurashi S; 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**D66:** Balestra C, Imbert JP, Egi SM, Ozyigit T; **D67:** Toklu AS, Koca E, Sam B, Arican N; **D68:** Sanders RW, Rublein T; **D69:** Lang MA, Van Hoesen KB; **D70:** Sanders RW, Anderson LH, Rublein TG; **D71:** Bodwin DM, Dunn SL, Holm JR; **D117:** Gomez-Castillo JD; **F114:** Clarke NW, Mackey MN, Wiley JM, Pollock NW; **E72:** Huang ET; **E73:** Huang ET; **E74:** Leis B; **E75:** Ptak J, Toutain-Kidd C, MacKenzie G, Zegans M, Buckey J; **E76:** Moffat AD, Churchill S, Deru K, Weaver LK; **E77:** Lo T, Song C, Alismail A, Terry MH, Bland D; **E78:** Wagner T; **E79:** Chin W, Jacoby L, Talati N, Jacoby R, Millbern C, Wegrzyn G, Sprau S; **E80:** Wilcox JR; **E81:** Santiago W, Wojcik S, Jennings S, Mariani P, Morgan M, Heyboer M; **E82:** Lo T, Song C, Alismail A, Bland D; **E83:** O'Neill OJ, Weitzner E; **E84:** Bello JH; **E85:** LeGros TL, Murillo I, Ulloa J, Buford K, Murphy-Lavoie H, Harch P, Van Meter K; **E86:** Guthrie SD, Salzberg CA, Hourani H, Rogers C; **E87:** Gatlin CG; **E88:** Yildiz S, Ozdemir A, Uzun G; **E89:** Stabile J, Weaver LK, Moffat A, Medford MA, Bell J; **E91:** Chin W, Talati N, Sprau S; **E92:** Bell JE, Deru K, Churchill S, Weaver LK; **E93:** Bell JE, Deru K, Koumandakis G, Weaver LK; **E94:** Wilson G, Churchill S, Deru K, Christoffersen PB, Weaver LK; **E95:** Dunn SL, Bodwin DM, Courtney TG, Holm JR; **E96:** Yagishita K, Enomoto M, Kato T, Horie M, Oyaizu T, Kojima Y, Koga H, Mano Y; **E97:** Wegrzyn G, Chin W, Millbern C, Ebrams E, Sprau S; **E98:** Fuqua WR, Narr T, Gossett W, Claus PL; **E99:** Medford MA, Moffat A, Hexdall E, Stabile J, Moon RE; **E116:** Oscarsson N, Arnell P, Lodding P, Ricksten SE, Seeman-Lodding H; **F100:** Nedwell JR, Mason TI, Collett AG, Gardiner RWK; **F101:** St Leger Dowse M, Cridge CEL, Waterman MK, Smerdon G; **F102:** Bergson M, Dennis R, Sulaiman N, Ferrigno M, Connor C; **F103:** Chin W, Huchim O, Wegrzyn G, Sprau S; **F104:** Chin W; **F105:** Chin W, Wegrzyn G, Millbern C, Jacoby R, Talati N, Sprau S; **F106:** Bourque JM, Ranapurwala SI, Denoble PJ; **F107:** Kohshi K, Tamaki H, Lemaitre F, Okudera T, Ishitake T; **F108:** Kojima Y, Enomoto M, Togawa S, Oyaizu T, Horie M, Yagishita K; **F109:** Oyaizu T, Yagishita K; **F111:** Ulloa J, Buford K, Murphy-Lavoie H, LeGros TL, Harch P; **F112:** Murillo IF, LeGros TL, Murphy-Lavoie H, Buford K, Wyatt HA; **F113:** Wolf EG, Flower AM, Richards MF, Bradley KR, Beckstrand DP, Krassow JL; **F114:** Clarke NW, Mackey MN, Wiley JM, Pollock NW; **F115:** Vann RD

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- Divers Alert Network: financial Silver Sponsor
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Signature of Activity Director/Coordinator Date: 5/27/2014

THERE WERE NO RELEVANT RELATIONSHIP(S) TO RESOLVE

Stacy Rupert

UHMS CME Coordinator

Continuing Education

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

In order to receive continuing education for the UHMS ASM you must complete and submit the online evaluation form at the following link https://www.surveymonkey.com/s/XXYDKLP (link is also on inside back cover). Hard copy can be supplied per your request.

Accreditation Statement: This activity has been planned and implemented in accordance with the Essential Areas and policies of the Accreditation Council for Continuing Medical Education (ACCME). The UHMS is accredited by the ACCME to provide continuing medical education for physicians.

Designation Statement

Physician Credits: The Undersea and Hyperbaric Medical Society designates this live activity for a maximum of **20.50** *AMA PRA Category 1 Credit(s)*™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

Nursing/RRT CEU will be provided by Wound Care Education Partners, 12900 Calais Circle, Palm Beach Gardens, FL. Florida Board of Registered Nursing Provider #50-10881. Credit hours **20.50.**

CHT/CHRN Credit hours will be provided by the National Board of Diving and Hyperbaric Medical Technology. This course has been reviewed and is acceptable for up to **21** Category A credit hours.

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Andover Healthcare Inc.: Salisbury, MA: TABLE #13: Andover Healthcare is a leading manufacturer of cohesive bandages and tapes for the healthcare, animal heath, and sports medicine industries. Founded in 1976, Andover is commited to new and innovative technology and distributes its patented products around the world. All Andover products are proudley made in the USA. **http://www.andoverhealthcare.com/**

Baromedical Nurses Association, Crystal River, FL: TABLE #24: The **BNA** provides nurses with a professional organization in order to maintain and promote the status and standards of practice in hyperbaric nursing. **http://www.hyperbaricnurses.org/**

Barnes-Jewish Hospital, St. Louis, MO: TABLE #16: Barnes-Jewish Hospital at Washington University Medical Center is the largest hospital in Missouri and the largest private employer in the St. Louis region. An affiliated teaching hospital of Washington University School of Medicine, Barnes-Jewish Hospital has a 1,800 member medical staff with many who are recognized as "Best Doctors in America." They are supported by residents, interns and fellows, in addition to nurses, technicians and other health-care professionals. **http://www.barnesjewish.org/**

Best Publishing Company, Palm Beach Gardens, FL: BOOTH # 1: Best Publishing Company was founded in 1966 and has become the largest and one of 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*, a peer reviewed quarterly publication that covers all aspects of wound care, diving medicine, and hyperbaric oxygen therapy (HBOT). We also produce the Wound Care & Hyperbaric Medicine Calendar that promotes diving, wound care, and hyperbaric education courses worldwide. **www.bestpub.com**

Divers Alert Network, Durham, NC: Booth # 7: Annual Meeting Silver Sponsor: The largest association of recreational scuba divers in the world, DAN is supported by membership dues and donations. DAN's mission is to help divers in need of medical emergency assistance and to promote dive safety through research, education, products and diving services. The benefits of DAN membership include emergency medical evacuation assistance through DAN *Travel Assist*, a subscription to *Alert Diver* magazine and access to DAN’s insurance services. **www.dan.org**

Environmental Tectonics Corporation, Southampton, PA: BOOTH # 8: ETC is a premier designer and manufacturer of clinical hyperbaric chambers serving a worldwide client base. The ETC BARA-MED monoplace has many unique features including fully redundant automatic and manual control systems, user-friendly SMOOTH•RIDE? compression protocol that significantly reduces complications due to middle ear squeeze without adding to compression time, and hard-copy record of the actual treatment profile. For more information on our products and product support services visit us at **www.etcBioMedical.com**.

Fink Engineering, PTY, LTD, Warana, Australia: TABLE #20: Fink Engineering Pty Ltd (a subsidiary of Fink International) was established in Victoria, Australia in 1987 to provide engineering design and consultancy to the offshore oil and diving industries. We have developed a world class set of Rectangular Hyperbaric Chamber Systems that are just beginning to be appreciated overseas as evidenced by systems shipped to New Zealand, Singapore, Canada and our recently completed projects in the USA. **www.fink.com.au**

Healogics, Jacksonville, FL: TABLE #14: Healogics is the expert in wound healing. We drive wound science forward by developing successful wound healing treatment and prevention techniques. Wound Care Centers® across the country work tirelessly to heal more wounds and change more lives than ever before. **www.healogics.com**

Hydrospace Group Inc., Claremont, CA: Booth #12: Hydrospace Group is dedicated to providing cost effective, innovative, high precision and reliable solutions for components, systems and vehicles designed to work underwater, from 20 to 20,000 feet. The dedication is rooted in the realization that the future will continue to demand new tools and methods to increase subsea productivity. These solutions will inherently combine a wide range of manned and unmanned technologies that need to work in concert. The harsh nature of this environment across the globe's oceans demands the highest levels of performance to achieve safety and reliability that will ensure commercial viability. **http://hydrospacegroup.com/**

Intellicure, The Woodlands, TX : TABLE #22: , Intellicure was developed by clinicians for clinicians. Our expertise and understanding empowered us to create a wound care software system that is built around your work flow needs. Intellicure provides clinicians with the tools they need to deliver evidence based care, ease concerns regarding billing and coding, facilitate clinical research, and make life easier. Intellicure is also at the forefront of research and development in the Wound Care and Hyperbaric community, working alongside healthcare professionals and vendors alike. By providing enormous amounts of quality data, Intellicure is a valued resource in its industry. **http://www.intellicure.com/**

International ATMO, Inc., San Antonio, TX: TABLE #19: Associate Luncheon Sponsor: International ATMO, Inc. is one of the oldest continuous providers of hyperbaric medicine education services including hyperbaric consulting, hyperbaric safety training, hyperbaric oxygen treatment, wound center consulting, wound care education and wound center management. International ATMO's continuing education courses in hyperbaric medicine, wound center management, wound care center education and safety training attract an international attendance of physicians, nurses, and technicians annually. The Hyperbaric Medicine Team Training Course is the original UHMS-Designated Introductory Course in Hyperbaric Medicine that meets the requirements of all Medicare Intermediaries. We also offer various hyperbaric education books, wound care center books as well as books from NFPA and UHMS. **www.hyperbaricmedicine.com**

Kinetic Concepts, Inc. San Antonio, TX: Booth #3: Kinetic Concepts, Inc. (KCI) is a leading global medical technology company devoted to understanding, developing and commercializing innovative, high-technology transformational healing solutions for customers and patients in more than 20 countries around the world. Headquartered in San Antonio, Texas, KCI is committed to advancing the science of healing and positively impacting patient care by developing customer-driven innovation to meet the evolving needs of healthcare professionals. **http://www.kci1.com/**

Masimo, Irvine, CA: BOOTH # 5: Masimo (NASDAQ: MASI) is a global medical technology company that develops and manufactures innovative noninvasive patient monitoring technologies, including medical devices and a wide array of sensors. A key medical technology innovator, Masimo is responsible for the invention of award-winning noninvasive technologies that are revolutionizing patient monitoring, including Masimo SET® pulse oximetry, Masimo Rainbow Pulse CO-Oximetry and new Masimo noninvasive and continuous total hemoglobin (SpHb™) monitoring technology. The recent introduction of the first-and-only FDA-cleared technology that noninvasively and continuously measures total hemoglobin without a painful needle stick and invasive blood draw is expected to open new markets and significantly expand the company's growth opportunities. **www.masimo.com**

National Board of Diving and Hyperbaric Medical Technology: Associate Luncheon Sponsor: The NBDHMT is the long-established and respected certification organization for those who support the delivery of undersea medicine and hyperbaric oxygen therapy. **www.nbdhmt.org**

Novadaq Technologies, Mississauga, ON, Canada: TABLE # 18: Enabling surgeons with clinically-relevant, innovative fluorescence imaging solutions to enhance the lives of patients and their surgeons, while reducing health care costs, is Novadaq's global mission. SPY fluorescence imaging technology provides surgeons with real-time visualization, leading to improved outcomes and reduced costs without exposing the patient to radiation. More than 65 peer-reviewed publications demonstrate that the use of SPY during complex surgery, leads to fewer post-operative complications and lower hospital costs. **www.novadaq.com**

Off-loading Technologies, Inc. Tarrytown, NY: TABLE # 26: Oxy-Mat (tm) Hyperbaric & Clinical Mattress systems " oxygen saturation technology."
www.OffLiad-USA.com

Organogeneis, Canton, MA: TABLE #21: Having pioneered the field, Organogenesis Inc. is a commercial leader in regenerative medicine, focused in the areas of bio-active wound healing and soft tissue regeneration. The company was originally founded in 1985 as a spin-off of technology developed at the Massachusetts Institute of Technology (MIT). The mission of Organogenesis is to bring the medical marvel of regenerative medicine to patients and standardize its use in everyday medical care. Initially our corporate mission was to "introduce regenerative medicine to the world." With more than 1 million units of Apligraf® and Dermagraft® - the leading regenerative medicine products in the world - shipped for patient use, we believe that we have successfully achieved this goal. **http://www.organogenesis.com/**

OSnovation Systems, Santa Clara, CA: Booth #11: OSNovative Systems, Inc. is a privately held company, owned and managed by a team of dedicated professionals. The company develops, manufactures and sells proprietary devices for advanced wound management, combat/emergency medicine and cosmetic skin care. **http://www.osnovation.com/**

OxyHeal Health Group, National City, CA: BOOTH #: 2: OxyHeal Health Group is made up of three corporations that have collectively been in business for over 35 years, specializing in the delivery of "high dose oxygen," or Hyperbaric Medicine, and the treatment of complex wounds. OxyHeal's member companies encompass both medical device manufacturing and the clinical operation of Hyperbaric Systems and Wound Healing Centers in Hospital and University programs worldwide. In addition, one of OxyHeal's companies operates didactic and on-line training programs for physicians, nurses and technicians. OxyHeal Health Group's predominant product is the company's unparalleled knowledge, training and experience in the delivery of Hyperbaric Oxygen Therapy and advanced wound care to patients both in clinical and emergency settings. **www.oxyheal.com**

Pan-America Hyperbarics, Inc., Richardson, TX: BOOTH # 4: Pan-America Hyperbarics, Inc., "The Highest-Value Provider in Hyperbaric Technology" is a worldwide supplier of monoplace and multiplace hyperbaric chambers. Our expertise is not only in designing and building bold new cost effective hyperbaric treatment systems, but also in developing partnerships with our clients. To assist our clients in providing the best standard of care to their patients, Pan-America Hyperbarics, Inc. offers unprecedented purchase, finance, and lease options for our products. For more information please contact our Partnership Care Team: 1-888-PAHI-HBO, or visit **www.panamericahbo.com**

Perimed, Inc., North Royalton, OH: BOOTH # 9: With over 25 years of development, Perimed AB manufactures and markets state-of-the-art Laser Doppler Instruments for the measurement of microvascular perfusion. As a leader in the Wound Care and Hyperbaric Medicine departments, Perimed, Inc., offers the only combined Laser Doppler and Transcutaneous multi-channel monitor, the PeriFlux 5000 system. This system allows the user friendly flexibility of multiple site monitoring. PeriFlux instruments represent a commitment that begins with quality and performance, and continues with technical and applications support. Please visit our website at **www.perimed-instruments.com**

Perry Baromedical, Riviera Beach, FL: TABLE # 17: Perry Baromedical is the only company in the world which designs, manufactures, installs and services monoplace, dualplace and multiplace hyperbaric chambers. We provide the highest quality product, and are focused on assisting hospitals with a comprehensive Hyperbaric Oxygen Therapy department. For further information visit our website at www.perrybaromedical.com or call us at 561-840-0395. **www.perrybaromedical.com**

Radiometer America, Westlake, OH: TABLE # 15: Radiometer is a leading provider of technologically advanced acute care solutions that simplify and automate all phases of acute care testing. Radiometer offers solutions for blood gas analysis, transcutaneous monitoring and immunoassay testing. **http://www.radiometeramerica.com/**

Reimers Systems, Inc., Springfield, VA: BOOTH # 6: With decades of experience, we offer hyperbaric chambers, research chambers, altitude chambers, oxygen service solutions, manifolds and other accessories like hood drivers, gas selection panels and utility penetrators, site development and engineering services, chamber installation and maintenance. Our sister company, Hyperbaric Clearinghouse, offers quality pre-owned chambers and equipment. **www.reimersystems.com**

Sechrist Industries, Anaheim, CA: BOOTH # 10; Associate Luncheon Sponsor: For over 30 years, Sechrist Industries, Inc., continues to be a leading worldwide manufacturer of hyperbaric chamber systems, neonatal, infant and pediatric intensive care ventilators, and air/oxygen mixers along with other ancillary accessories. All products are manufactured in accordance with FDA and GMP regulations. **www.sechristusa.com**

Soluble Systems, Newport News, VA: TABLE # 25: Soluble Systems, LLC, markets a line of advanced wound care products under the brand names of TheraSkin® and TheraGauze®. The Company's products compete in the U.S. within two large and growing wound care markets, biologics and synthetic dressings. Both TheraSkin and TheraGauze are designed to help healthcare professionals treat difficult-to-heal chronic wounds where co-morbidities, age, diabetes and other factors are driving the need for clinically and cost effective wound healing.

EXHIBIT TIMES:

Thursday, June 19:

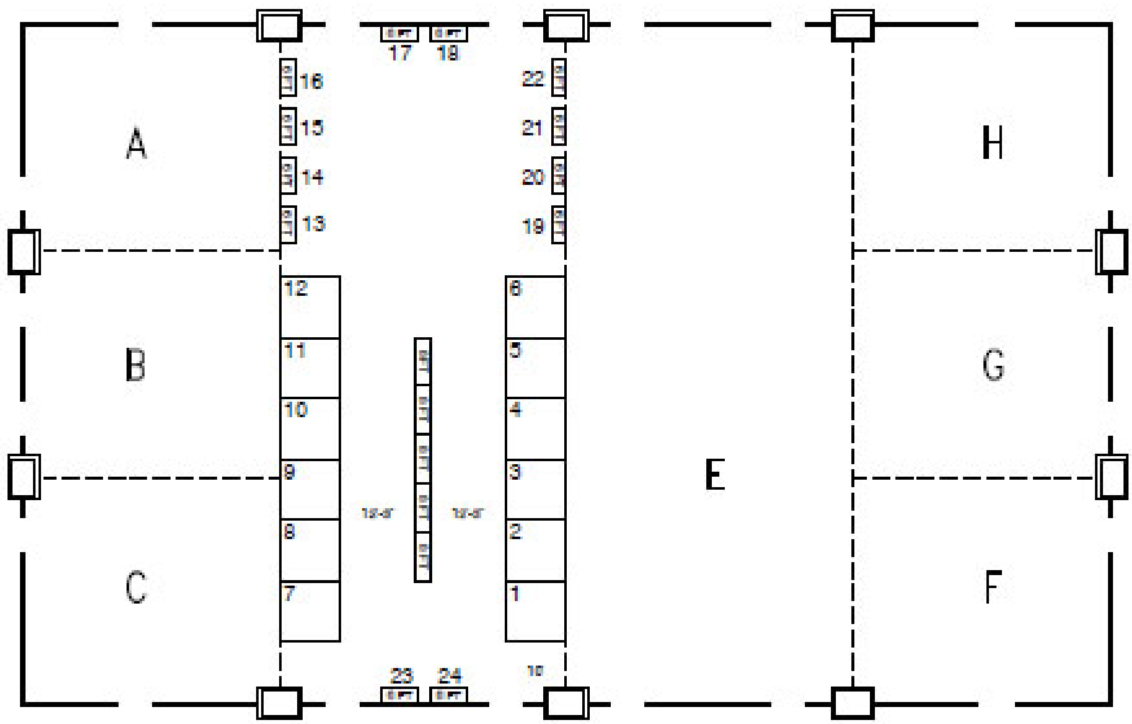
7-8am (Exhibits/Continental Breakfast)
9:30-10am (Exhibits/Break)
3:30-4:00pm (Exhibits/Break)
5:30pm-6:30pm: Meet the Exhibitors "Wine & Cheese" Reception

Friday, June 20:

7-8am (Exhibits/Continental Breakfast)
9:30-10am (Exhibits/Break)
3:00-3:30pm (Exhibits/Break)

Saturday, June 21:

7-8am (Exhibits/Continental Breakfast)
9:30-10am (Exhibits/Break)
4:00-4:30pm (Exhibits/Break)



1	Best Publishing	9	Perimed	17	Perry Baromedical
2	OxyHeal	10	Sechrist	18	Novadaq
3	KCI	11	Osnovative Systems	19	ATMO
4	Pan America	12	Hydrospace Group, Inc.	20	Fink
5	Masimo	13	Andover Health	21	Organogeneis
6	Reimers Systems Inc	14	Healogics	22	Intellicure
7	Divers Alert Network	15	Radiometer	23	Baromedical Nurses
8	ETC	16	Barnes-Jewish Hospital	24	APBM

THURSDAY
JUNE 19

SESSIONS
A & B

ASSOCIATE BREAKOUT SESSION
IS IN BALLROOMS B & C
FROM 8:30-5:45

President's Address

John Feldmeier, DO, FUHM

0800 - 0830

JOHN FELDMEIER, DO, FUHM

A 1970 graduate of Duquesne University in Pittsburgh, Dr. Feldmeier initially served as a meteorologist in the USAF Weather Service until 1975. He received his D.O. degree from The Philadelphia College of Osteopathic Medicine in 1979 with USAF sponsorship and completed residency training in Radiation Oncology at the University of Texas Health Science Center at San Antonio, Texas. He received a fellowship certificate from the USAF Hyperbaric Medicine Fellowship Training Program at Brooks Air Force Base in San Antonio, Texas and was a staff physician there from 1980 to 1982. Dr. Feldmeier then served as the Chief of Radiation Oncology from 1985 to 1987 and ultimately simultaneous Chairman of the Hyperbaric Medicine Department at Wright-Patterson Air Force Base Medical Center in Dayton, Ohio. He returned to the University of Texas Health Science Center as faculty in 1987 and ultimately became Chief of Radiation Oncology there. He was also the Radiation Oncology Residency Program Director there before leaving to join the faculty at Wayne State University. He became Division Chief and Clinical Chief of Radiation Oncology at Grace Hospital in Detroit, Michigan in 1993. In 1997 he joined the University of Toledo and served as Department Chairman of Radiation Oncology there until his retirement from that position in 2013. He was named Professor Emeritus upon his retirement.

Dr. Feldmeier has authored numerous publications in both radiation oncology and hyperbaric medicine. He has been the editor of the Undersea & Hyperbaric Medical Society (UHMS) Hyperbaric Oxygen Therapy Committee Report which provided the rationale for the UHMS Accepted Indications for HBO2. He served a review editor of the UHMS scientific journal, Undersea and Hyperbaric Medicine. He is a Fellow of Undersea and Hyperbaric Medicine and is the current sitting President of the UHMS. He is a Fellow of the American College of Radiation Oncology. He has been recognized as one of "The Best Doctors in America" since 2007.

<u>ABOUT THIS LECTURE:</u>

The President's Address is intended to welcome meeting participants, provide an overview of the UHMS Annual Scientific Meeting's organization and planned presentations, and discuss topics of contemporary interest to the UHMS membership. These topics will primarily include identification of ongoing challenges to the Undersea and Hyperbaric Medicine profession and updates regarding current UHMS strategic initiatives.

Plenary Session: Update on Clinical Practice Guidelines in Hyperbaric Medicine

Enoch Huang, MD, FUHM & Jaleh Mansouri, MD, MPH

0830 - 0930

During this lecture the lecturers will share with you how the UHMS intends to utilize the GRADE methodology to create a series of Clinical Practice Guidelines regarding the use of hyperbaric oxygen therapy for accepted indications. The lecturers will also break down the strengths and weaknesses of the current body of literature for HBOT in order to guide future areas of research, including study design and outcomes of interest.

SESSION A
DIVING/DECOMPRESSION ILLNESS: THEORY & MECHANISMS

A 1

ORAL PRESENTATION TIME: 1000 - 1012
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: NO

EXHALED NITRIC OXIDE FOLLOWING REPEATED 6-HOUR IMMERSED EXERCISE DIVES AT 1.35 ATM

Fothergill DM, Florian JP, and Shykoff BE
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Background: Previous research has shown that exhaled nitric oxide (NO_{exp}) temporarily decreases following dry resting hyperbaric oxygen exposures in a dose dependent manner (UHM 38:430, 2011). This suggests that NO_{exp} may provide a useful noninvasive measure of lung oxidative stress following prolonged hyperoxic dives. The objective of this study was to determine if the combined effects of immersion and exercise significantly affect the hyperoxic mediated decrease in NO_{exp} following prolonged multi-day dives.

Methods: Twelve military divers volunteered to conduct five six-hour dives on sequential days breathing 100% oxygen at 1.35 atm in a heated pool. Throughout each dive they performed repeated bouts of 30 min of prone bicycle exercise (target heart rate of 95±5 beats/min) and 30 min of seated rest. A separate control group of military divers (n=14) conducted the same multi-day dive profile with the same exercise protocol except that they breathed compressed air at 1.35 atm. NO_{exp} was measured immediately before and immediately after each dive using a NIOX MINO nitric oxide analyzer.

Results: The oxygen dives resulted in a daily mean±SD post-dive NO_{exp} decrease of between 40.0±10.5% and 46.2±14.7% ($p<0.0001$; n=10). The decrease in NO_{exp} was similar across days ($p=0.506$) and was not significantly different from that previously observed in divers exposed to a similar hyperoxic dose under dry resting conditions in a hyperbaric chamber (UHM 38:430, 2011). The daily mean±SD relative change in NO_{exp} following the air dives was between +2.8±25.2% and -4.8±13.2%, with the post-dive NO_{exp} not differing significantly from the pre-dive values at any point during the dive week ($p=0.643$; n=14).

Conclusions: Immersion and exercise do not significantly affect the hyperoxic mediated post-dive decrease in NO_{exp}. Consecutive multi-day dives do not appear to modulate the magnitude of the hyperoxic mediated post-dive decrease in NO_{exp}.

Acknowledgements: *Funded by the Office of Naval research (work unit # N0001413WX20689) through the In-house Laboratory Independent Research (ILIR) program to DMF and NAVSEA (work unit # N0002411WX02303) to JPF.*

A 2

ORAL PRESENTATION TIME: 1012 - 1024
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: NO

GAS PRESSURES ASSOCIATED WITH DIVING TRIGGER MICROPARTICLE PRODUCTION BY NEUTROPHILS

Thom SR, Bhopale VM, Yang M
SThom@smail.umaryland.edu

Introduction: Circulating microparticles (MPs), 0.1 – 1.0 nm vesicles, are elevated in animals and humans after simulated or *bona fide* underwater diving. Animal studies suggest MPs trigger inflammatory responses and tissue damage associated with decompression but the mechanism for MPs production is unknown. Findings from these murine studies and also several trials involving human divers caused us to hypothesize that MPs production may occur because of high pressure exposures, rather than a consequence of decompression *per se.*

Materials and Methods: Neutrophils isolated from blood of healthy humans and mice were subjected to elevated partial pressures of helium, nitrogen, argon or to hydrostatic pressure without a gas phase. MPs production was assessed and mechanisms investigated based on effects of chemical inhibitors and reducing levels of specific proteins with small inhibitory RNA.

Results: The threshold for MPs production by human neutrophils to generate MPs is ~186 kPa (60 fsw) for 30 minutes or longer. MPs are generated during pressure exposure, not on decompression and production rate rises linearly with pressures (0.13 MPs/cell at 186 kPa, 3.34 MPs/cell at 690 kPa). Murine cells behave similarly but MPs production continues to occur even after decompression. MPs are generated by neutrophils exposed to elevated gas but not hydrostatic pressure according to the potency series: argon > nitrogen > helium. Following a similar pattern, gases activate type-2 nitric oxide synthase and NADPH oxidase and the reactive species generated alter regulation of actin polymerization which leads to activation of enzymes required for MPs formation.

Summary: We conclude that MPs production is an oxidative stress response to high inert gas pressure.

A 3

ORAL PRESENTATION TIME: WITHDREW
POSTER PRESENTATION TIME: WITHDREW
RESIDENT COMPETITION:

ANTIOXIDANT STATUS IN RATS FOLLOWING SIMULATED SATURATION DIVING

Yang T, Fang YQ, Li C, Huang ZQ, He J, Chen HT
tonioyang@aliyun.com

WITHDREW

A 4

ORAL PRESENTATION TIME: 1036 - 1048
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: NO

THE EFFECTS OF HYPERBARIC OXYGEN APPLIED FOR ONE AND FIVE DAYS ON BLOOD BRAIN BARRIER PERMEABILITY IN RATS

Tatar S, Arican N, Orhan N, Yılmaz CU, Ahishali B, Kaya M, Toklu AS
akin@toklu.net

Introduction: The studies about the effect of hyperbaric oxygen (HBO) on blood-brain barrier (BBB) permeability are limited. In this experimental study, the effects of HBO applied for one and five days, on blood-brain barrier (BBB) permeability and oxidant-antioxidant systems were investigated in rats.

Materials and Methods: Healthy young female Wistar albino rats were divided into three groups as, control, HBO administered for 1 day (HBO-1) and HBO adminestered for 5 days (HBO-5) groups. Hyperbaric oxygen sessions were set as; compression in 15 min, 100% oxygen for 60 min at 2,5 ATA and decompression in 15 min. Three HBO sessions were applied to HBO-1 group with 6 hours intervals in 24 hours. Twelve HBO sessions were applied to the HBO-5 group as; 3 sessions a day in first two days and twice a day during the last three days. The rats were catheterized about 2 hours after the last hyperbaric sessions to inject horseradish peroxidase (HRP), to make the fixation for immunohistochemical evaluation, to take tissue samples for measurement of the oxidant-antioxidant level and decapitation. BBB permeability was examined electron microscopically by using HRP tracers.

Results: When examined by electron microscopy, it was observed that HRP couldn't pass through BBB in control group, but it was passed in HBO-1 and HBO-5 groups. Immunohistochemically, no significant difference was detected between groups. GSH levels in cerebral cortex and hippocampal tissues in HBO-1 and HBO-5 were measured significantly lower comparing to control group. SOD activities in both experimental groups were higher than control group. MDA levels in cerebral cortex and hippocampal tissues were lower in both HBO-5 and HBO-1 groups.

Conclusion: HBO administered to healthy rats for 1 and 5 days caused an increase in BBB permeability to HRP, decrease in MDA and GSH level in brain tissue and slight increase in SOD activity.

A 5

ORAL PRESENTATION TIME: 1048 - 1100
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: NO

HBO2-TRIGGERED BAROREFLEX: MECHANISMS, PATHWAYS, BENEFITS AND LIMITATIONS

Demchenko IT, Gasier H, Allen BW, Piantadosi CA
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Background: Hyperbaric hyperoxia shifts sympathovagal balance by increasing parasympathetic tone and decreasing sympathetic drive. We tested whether activation of the arterial baroreflex is a major contributor to this alteration in autonomic equilibrium and evaluated its mechanisms of initiation, neuronal pathways, effects on cardiovascular function and brain excitability, and its functional limitations.

Methods: Rats were exposed to O_2 at 2.5-6 ATA. Cardiovascular variables (arterial and left ventricular blood pressures, cardiac output and cerebral blood flow) and bioelectric markers (ECG, ECG and renal sympathetic nerve activity) were measured. Vascular resistance, baroreflex sensitivity, heart rate variability and sympathovagal balance were calculated. Baroreflex function in HBO_2 was evaluated after aortic and carotid baroreceptor deafferentation, vagotomy; electrical stimulation of aortic depressor nerves or vagus nerve; or local NOS inhibition in the medulla or hypothalamus.

Results: (i) HBO_2 triggers the baroreflex by an increase in blood pressure due to peripheral vasoconstriction from reduced bioavailability of nitric oxide (NO). Baroreflex activation results in bradycardia, decreased cardiac output and diminished arterial pressure. These responses are abolished by deafferentation of the baroreceptors, demonstrating the role of baroreflex afferent pathways. (ii) In moderate levels of HBO_2 ($\leq$ 2.5 ATA), baroreflex function is enhanced due parasympathetic activation and sympathetic withdrawal. (iii) In extreme levels of HBO_2 (5-6 ATA), vagal tone falls and sympathetic drive rises, leading to baroreflex attenuation. This imbalance precedes HBO_2 seizures and is accompanied by cardiac dysfunction and acute pulmonary hypertension. (iv) Electrical stimulation of the aortic depressor or vagus nerves or NOS inhibition in the medulla or hypothalamus prolong parasympathetic restraint, prevent sympathoexcitation, diminish pulmonary hypertension, improve cardiac function and delay EEG spikes.

Conclusions: Physiological activation of the arterial baroreflex during HBO_2 has two protective functions: it limits convective delivery of oxygen to the brain and restrains brain excitation, preventing oxygen seizure development.

Supported by the Office of Naval Research

A 6

ORAL PRESENTATION TIME: 1100 - 1112
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: YES

NAVSEA 2 COGNITIVE TESTING AT HIGH WORKLOAD LEVELS IMPROVES PERFORMANCE DISCRIMINATION ON THE MULTI-ATTRIBUTE TASK BATTERY-II

Viola.JH, Derrick BJ, Cobb T, Natoli MJ, Schinazi EA, Martina SD, Qin M, Medford M, Scafetta N, Moon RE, Freiberger JJ
judith.viola@duke.edu

Introduction: When cognitive testing is too easily mastered (performance ceilings) it will fail to discriminate among levels of impairment such as those caused by breathing gas narcosis during diving. Using NASA's MATBII aviation simulation software, the pilot phase of this project showed that TRACKING accuracy at LOW workloads was NOT consistently affected by elevated PCO2 or PN2 (see companion abstract). Because we suspected that this was likely due to performance ceiling effects, we evaluated HIGH versus LOW workload conditions to test if HIGH workloads might counteract the TRACKING task ceiling effect observed.

Methods: Ten subjects were studied using a HIGH (n=4) or LOW n=6) workload MATBII configuration under surface room-air conditions. The HIGH workload configuration used all MATBII tasks simultaneously (TRACKING, SYSMON, COMM and RESMON). The LOW workload scenario was limited to TRACKING and SYSMON only.

Results: High versus LOW workload TRACKING was significantly impaired as evidenced by an increase in the second-by-second mean pixel distance from the target from: 33.23 (95%CI 32.5-33.9) to 37.43 (95%CI 36.2-38.6) pixels. (HIGH versus LOW workloads respectively, $p<.001$ ANOVA). Increasing the numbers of practice sessions significantly and independently improved performance but did not influence the workload effect (p.001 linear regression). Accuracy of the SYSMON tasks was not comparatively different 2 at HIGH versus LOW workloads, however, reaction time was significantly longer (mean RT HIGH=2.12 versus LOW =1.75 ± 0.84sec) during HIGH workload scenarios for more difficult "scale" components of the SYSMON task.

Conclusions: TRACKING accuracy at LOW workloads was NOT consistently affected by elevated PCO2 or PN2, likely due to performance ceiling effects. However, at HIGH workloads TRACKING accuracy decreased even while breathing non-narcotic room air. HIGH workload testing is planned to isolate the effects of narcotic gases on the selective preservation of accuracy of the TRACKING task.

Acknowledgements: Funding provided by NAVSEA Deep Submergence Biomedical Contract #N0463A-12-C-0001.

A 7

ORAL PRESENTATION TIME: 1112 - 1124
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: NO

NAVSEA 1 MEASUREMENT OF NITROGEN AND HYPERCAPNIC NARCOSIS USING NASA'S MATBII SOFTWARE

Derrick BJ, Cobb T, Natoli MJ, Schinazi EA, Martina SD, Qin M, Viola.JH, Medford M, Scafetta N, Moon RE, Freiberger JJ
bjd17@cornell.edu

Introduction: The Multi-attribute task battery-II (MATB2) is a suite of NASA developed, computer-based flight simulation software tests designed to evaluate operator performance and workload during operationally realistic scenarios. We used the MATBII to assess the effects of N2 and CO2 narcosis at operationally relevant gas partial pressures.

Methods: After institutional approval and informed consent, 8 pilot subjects were studied during head-out immersion at rest and at 50-watt cycle-ergometer exercise. Direct arterial and mass-spectrometry derived CO2 (PaCO2 and PETCO2) were measured at sea-level (Durham, NC) and under hyperbaric conditions (PIN2 = 0, 0.8, 4.5 and 5.6 ATA; PIO2 = 0.2, 1, and 1.3 ATA with and without 7.5% surface equivalent value CO2). Cognitive performance was assessed using the TRACKNG and SYSMON tasks of the MATBII.

Results: Elevated PN2 and PCO2 decreased accuracy for the SYSMON attention/surveillance related tasks by approximately 30% ($p=<.001$ chi-square) and increased reaction time variability (dive coefficient of variation (CV) > surface room-air CV). However, TRACKING accuracy at LOW workloads was NOT consistently affected by elevated PCO2 or PN2, likely due to performance ceiling effects. At HIGH workloads, TRACKING accuracy decreased even while breathing non-narcotic room air (see companion abstract).

Conclusion: Although attention /surveillance tasks are sensitive to LOW workload testing regimens, HIGH workload testing will be required to unmask the narcotic gas impairment threshold for the TRACKING task. These additional tasks will also provide additional memory and problem solving data for analysis under the proposed experimental conditions. Finally, HIGH workload testing may also help identify scenarios where skilled subjects develop strategies to mask overall cognitive impairment by selectively sacrificing one task in order to maintain competence in others. Further pilot testing at HIGH workloads under conditions of elevated PO2, PN2 and PCO2 is planned.

Acknowledgements: Funding provided by NAVSEA Deep Submergence Biomedical Contract #N0463A-12-C-0001.

A 8

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: WITHDREW
RESIDENT COMPETITION: NO

HOW COULD DIVER'S PRE-EXISTING MICRO-BUBBLES BE STABILIZED?

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WITHDREW

A 9

ORAL PRESENTATION TIME: 1024-1036
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: NO

PERFUSION-DIFFUSION GAS CONTENT COMPARTMENTAL MODELS AS A PRECITOR OF DECOMPRESSION SICKNESS

Murphy FG, Hada EA, Doolette DJ, Howle LE
normoxic@gmail.com

Introduction: Probabilistic models of decompression sickness (DCS) typically rely upon models composed of a series of parallel perfusion-limited compartments that describe gas content and in some cases bubble volume within theoretical tissues. Doolette, Upton, and Grant proposed a series of perfusion-diffusion based models as descriptors of the helium uptake and washout kinetics they observed in cerebral blood flow and skeletal muscle of sheep [1,2]. They found that for both skeletal muscle and cerebral blood flow their data were best fit using a combination of coupled perfusion and diffusion limited compartments. We have investigated whether or not these model structures lead to a better prediction of the incidence of DCS.

Methods: The models were programmed in C++ and fit to the p97 dive data set by the method of likelihood maximization using the Levenberg-Marquardt algorithm on both standard PCs at Duke University and an IBM Blue Gene/Q platform located at Argonne National Laboratory (ANL).

Results: There is experimental evidence supporting the hypothesis that the uptake and washout of inert gas is not strictly perfusion-limited. Applying perfusion-diffusion model structures within a probabilistic framework for predicting the incidence of DCS allows for more physiologically consistent gas content models. We report on the performance of these models in comparison with a standard perfusion-limited parallel compartment model.

[1] Doolette DJ, Journal of Applied Physiology 2005; 563.2:529-539
[2] Doolette DJ Acta Physiologica Scandinavica 2005; 185:109-121

Supported by ONR Grant #N00014-13-1-0063, NAVSEA Contract # N00024-13-C-4104. This research used resources of the Argonne Leadership Computing Facility at Argonne National Laboratory, which is supported by the Office of Science of the U.S. Department of Energy under contract DE-AC02-06CH11357.

A 10

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: NO

DEPTH SCALING OF SEVERAL GAS SUPER-SATURATION DECOMPRESSION MODELS

Hada EA, Howle LE, Murphy FG
ethan.hada@duke.edu

Introduction/Background: Early U.S. Navy probabilistic decompression sickness (DCS) models used various forms of gas super-saturation as hazard functions [1]. Later DCS models used a super-saturation ratio in order to reduce over-prediction of DCS in deep dives [2]. Recently, a super-saturation ratio with an exponentiated numerator was used in predicting the probability that high-risk dives would result in DCS [3]. In that model, the exponent was frozen and not fitted. In the present work, we explored various super-saturation and super-saturation ratio models with and without fitted exponents in order to explore the predictive quality of these DCS models.

Materials and Methods: We fitted five gas content model catagories by the method of maximum likelihood to BIG292. The five models all used parallel, well-perfused exponential gas kinetics. Models differed only in the functional form of their hazard function. Models included super-saturation (SS), super-saturation ratio (SSR), super-saturation exponentiated (SSE), super-saturation ratio exponentiated (SSRE), and super-saturation ratio exponentiated numerator (SSREN) derivatives. Models had between six and 12 fitted parameters. Multi-model inference was carried out by Akaike information criterion (AIC) [4].

Summary/Conclusions: AICc weight-ranked the models according to evidence ratios. Of the 16 models explored, 4 were needed to account for >99% of the available AICc weight. The four models (SRE111(T), SREN111(T)) all had individual compartmental exponent parameters. The AIC weighted four-model results provided the best balance of predictive capabilities.

[1] Weathersby, Homer & Flynn. 1984. J. Appl. Physio. 57(3):815-825.
[2] Weathersby, Survanshi, Homer, Hart, Nishi, Flynn & Bradley. 1985. NMRI 85-16.
[3] Weathersby & Gault. 2012, UHMS Scientific Meeting Abstract D71.
[4] Burnham & Anderson. 1998 Model Selection and Multimodel Inference. Springer.

Supported by NAVSEA Contract # N00024-13-C-4104

A 11

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: WITHDREW
RESIDENT COMPETITION:

DECOMPRESSION MODELS: REVIEW, RELEVANCE AND VALIDATION CAPABILITIES

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WITHDREW

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ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: NO

HYPERBARIC OXYGEN PRECONDITIONS ON SPINAL NEURONS AGAINST INJURIES VIA UP-REGULATION OF HEAT SHOCK PROTEIN 32

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Introduction/Background: Spinal cord decompression sickness (DCS) is a serious problem in diving. Effective preventive measures are in desperate need to reduce the injury. Our previous study found that hyperbaric oxygen preconditioning (HBO-PC, HBO more than ten hours prior to injuries) significantly reduced the incidence of DCS in rats and heat shock proteins (HSPs) were involved in the beneficial effects. To elucidate the mechanism, the protective effects of HBO-PC on the primary cultured spinal neurons against oxidative stress and oxygen-glucose deprivation (OGD) injuries were investigated.

Methods: Rat spinal neurons were primarily cultured and mRNA and protein levels of HSPs (90, 70, 32 and 27) were detected at different time points following a single HBO exposure (280 kPa, 60 min) by QRT-PCR and Western blot, respectively. By determining lactate dehydrogenase (LDH) release and cell viability, the injuries induced by hydrogen peroxide (H_2O_2) or OGD were assessed for neurons pre-treated with HBO, HBO plus the respective HSP inhibitor and the control. The activation of eleven key signaling molecules was determined by protein microarray.

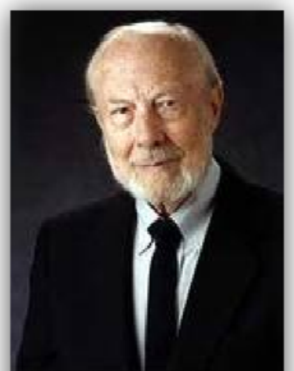
Results: The results of Western blot and QRT-PCR showed that only HSP32 significantly increased, with the highest expression at 12 h following HBO exposure. HBO-PC significantly increased the cell viability and decreased the medium LDH content in cultures treated with H_2O_2 or OGD. The protective effects of HBO-PC were significantly abrogated when pretreatment with a specific inhibitor of HSP32 (zinc protoporphyrin IX). ERK1/2, p38MAPK, CREB and Nrf2 were significantly activated by HBO.

Conclusions: These results suggest that HBO-PC increased the ability of spinal neurons to counteract injuries by up-regulating of HSP32. The reveal of exact signaling transduction is still under progress.

LAMBERTSEN LECTURE: *To The Very Depths*

Peter Bennett, PhD, DSc, FUHM

1315 - 1415


Christian J. Lambertsen, M.D.

Christian J. Lambertsen, M.D., D.Sc. (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.*

LAMBERTSEN MEMORIAL LECTURE
KEYNOTE SPEAKER
Peter B. Bennett, PhD, DSc, FUHM

Dr. Bennett was elected Foreign Member of the Russian Academy of Science in 1994 and the Dr. Honoris Causa (Honorary Degree), University of the Mediterranean, France in 2001.

He has been involved with hyperbaric medical research for over 63 years in 5 countries, published 9 books and over 250 scientific papers.

A UHMS Charter Member in 1967, he was a member of the Executive Committee, 1972-1975; President, 1975-1976; Editor UHMS Undersea and Biomedical Research Journal, 1976-1979; Editorial Board, 1979-1982 and 1987-1991; Nominations Committee 1989 and Executive Director, UHMS from 2007-2014.

From 1953 to 1972 he served the UK Royal Naval Scientific Service at the RN Physiological Laboratory (RNPL) in Alverstoke near Portsmouth. His research covered underwater blast, drowning, inert gas narcosis, oxygen toxicity, decompression sickness and first discovered the High Pressure Nervous Syndrome (HPNS). From 1966-1968 he was on loan to DCIEM in Toronto, Canada for 2 years to initiate a new diving medicine department with a new 300 ft chamber and staff.

On return to RNPL in 1970, he directed a world record oxygen-helium dive to 1,500 ft. In 1972 he left RNPL as Deputy Director and Principal Scientific Officer with a staff of 60 for the United States. He was invited to Duke University Medical Center for a tenured position as Professor in the Department of Anesthesiology and Co-Director of the F.G. Hall Environmental Laboratory (now Hyperbaric Center). He became Director, 1977-1988 and Senior Director 1988-2007.

His research work continued on very deep diving and culminated in the development of TRIMIX ($He/N_2/O_2$) to prevent HPNS. He directed a number of world record deep TRIMIX dives eventually reaching 2,250 ft in 1981.

A large number of further deep working TRIMIX dives with welding and other research to depths of 600 m (2,132 ft) were carried out in Germany at the new GUSI (German Underwater Simulator).

Other research at Duke involved anesthesia mechanisms, decompression theory and the "deep stop," nitrogen narcosis and oxygen toxicity mechanisms, HBO_2 therapy including directing a research study on multiple sclerosis and initiated clinical HBO_2 therapy at Duke with Dr. Enrico Camporesi and later Dr. Richard Moon as Directors.

In 1980, he founded the Divers Alert Network (DAN). As President and CEO of this non-profit he grew DAN at 20% per year to a $16 Million organization with over 200,000 Members, a staff of 80 and its own office building. He retired from DAN in 2003.

By then, the DAN emergency hotline had helped more than 33,000 recreational divers with acute diving injuries; more than 180,000 advisory assistance and information calls; over 100,000 certification as DAN O_2 instructors and 150,000 certified as Oxygen Providers.

He has received over 18 international and American awards, including the UHMS 1st Oceaneering Award in 1975, the UHMS Behnke Award in 1983, First Prince Tomohito of Mikasa Prize (Japan) in 1990, the UHMS Craig Hoffman Award in 1992, the Joseph Priestly Lecture, Penn State College of Medicine in 1999, the Pavlov Medal Russian Academy of Sciences in 2001, Diving Equipment Manufacturers Assoc "Reaching Out Award" in 2002, Ernst and Young Entrepeneur of the Year North and South Carolina in 2002, British Historical Society Reg Vallentine Award, in 2003, British SubAqua Jubilee Trust Colin McLeod Award in 2011. He is listed in Marquis Who is Who in the USA and Marquis Who is Who in the World.

To The Very Depths

It is very difficult to review 63 years of my work in hyperbaric medicine and diving in one hour. A fuller description of my work in 5 countries was given in my memoir, "To the Very Depths," published by Best Publishing in 2008. Some copies will be available at the registration desk. This Lambertsen Lecture will cover some of the highlights.

During World War II, the bombing in Portsmouth, where I was born was extreme and eventually included my home. My father, an engineer expert on aircraft carrier catapults and gun mountings was sent to Bombay with the family in 1941 as the Japanese entered the fray. I returned to the UK in 1945. I then did 2 years compulsory service in the RAF in Germany from 1951 to 1953.

On return to the UK, I entered the RN Scientific Service at the Royal Navy Physiological Laboratory (RNPL), which was responsible for diving and submarine escape research for the Royal Navy. It had a number of pressure chambers capable of 300 fsw depths. The biggest was a Siebe Gorman riveted chamber and the smallest was a very small recompression chamber with no entry lock, but a medical hatch and designed as a "treatment chamber" in the event of decompression sickness! My early research consisted of experiments on drowning and underwater blast due to the large numbers killed in the water from sinking ships during the war.

I however started my own projects on nitrogen narcosis in the small recompression chamber. These included dives to 300 ft for a month to study acclimation of narcosis signs and symptoms, breathing other gases like argon at pressure and experiments in connection with submarine escape.

In 1951, a British submarine "Affray" sank in the English Channel at 83 m (266 ft) with all 73 on board. This stimulated new research for better escape methods. The old compartment escape method used a flooded compartment with all survivors and one at a time escaping. Due to the long time involved, there was a major risk of decompression sickness and death for late escapees. As time progressed a single small compartment was proposed.

This was sufficient for one or two men in a chamber in an immersion suit that could be compressed very rapidly in 15-20 seconds to the water depth to avoid decompression sickness. Compression and exit from the escape hatch was to be done in 1 minute or less! Research was carried out at 400 and 500 feet to determine if narcosis would be a problem and some narcosis was determined even in this short time at 500 ft. However, escapes were made satisfactorily from 600 ft.

This stimulated more deep sea research. As a result, Lt. Wookey, in 1956 made a record dive near Norway from HMS Reclaim to 600 ft breathing oxygen-helium for a few minutes. He found it very cold and developed limb decompression sickness. When asked if he would do it again he said “only if I had too.” He died at age 84 last year.

Challenged by the 600 ft escape limitations, research continued to look for deeper submarine escape possibilities. So I exposed volunteers in 1965 to 600 ft and 800 ft chamber dives with oxygen-helium to avoid narcosis and at compression rates of 100 ft/min. Unexpectedly, there were performance decrements equivalent to 300 ft on air accompanied by tremors of the hands, nausea and vomiting. The cause was not clear and I called it “Helium Tremors” as did Russian workers from the same findings in their deep oxygen-helium diving as I found out 20 years later! During future research I called it the High Pressure Nervous Syndrome (HPNS).

In 1950, Johnson and Flagler had discovered pressure reversal of narcosis or anesthesia. So in 1967, I went to Cambridge University in connection with research on mechanisms of anesthesia and narcosis to join research with Dr. Bangham amd Dr. Papajopoulos. They were measuring surface tension of egg phospholipid model cell membranes, which correlated with narcotic potency and expansion of the membrane to affect central synapses. When I exposed He, N_2, A, O_2 and CO_2 there was a fall in surface tension indicating expansion. All except helium and later neon showed the opposite, an increase in surface tension, implying membrane constriction as a possible cause of the helium tremors or High Pressure Nervous Syndrome (HPNS).

In 1966 came my first book, “The Etiology of Compressed Air Intoxication and Inert Gas Narcosis,” by Pergamon Press. Based on my Ph.D. thesis, about this time I was offered a position at the Experimental Diving Unit in Washington but the Director at RNPL refused to let this happen!

The Canadians were more careful in inviting me to come to Canada and DCIEM in Toronto in 1966 by proposing only a 2 year loan. They wanted me to initiate a new diving medicine research department with a new 300 ft chamber and staff. The chamber arrived and was installed and staff acquired and trained. Research work involved using a 1,000 ft animal chamber to study evoked potentials during oxygen toxicity for its effect on GABA and the use of evoked potentials in compressed air and oxygen narcosis. In humans, relation of serum surface tension to decompression sickness, testing the Kidd-Stubbs computer and personally carrying out over 90 dives myself between 200-300 ft with 6 men per dive.

Also, in 1969 the first edition of “The Physiology and Medicine of Diving” was published, edited by myself and surgeon Lt. Cmdr. David Elliott to be followed by 3 further editions over the years and one in Russian.

Although I was later asked to stay at DCIEM, in 1968 I returned to the RNPL! Earlier in 1962 Hannes Keller, a Swiss mathematician had apparently no problems in dives to 1,000 ft with no HPNS. In 1969, we invited them to come to RNPL to demonstrate a Heliox 1,000 ft dive. This did show mild HPNS for the first hours after compression but otherwise the dive was very successful with excursions in the water to 1,150 ft. However, compression was much slower than the early RNPL 600 ft and 800 ft dives.

So it was decided in 1970 to carry out at RNPL a 1,500 ft oxygen helium dive with stages of 24 hour at 600 ft, 1,000 ft, 1,300 ft and 1,500 ft for extensive scientific measurements on two volunteers, John Bevan and Peter Sharplouse. This world record depth was reached with minimal HPNS but some decompression problems. It was decided the slow compression was very effective.

In 1972 I was offered a tenured Professor position by Dr. Merel Harmel and Dr. Herb Saltzman at Duke University Medical Center in the Department of Anesthesiology to head up the new F.G. Hall Environmental Laboratory (now Hyperbaric Center) and left RNPL and England for North Carolina.

The early years at the Duke facility were involved with basic research on anesthesia mechanisms and oxygen toxicity and considerable work on commercial decompression from deep 500 ft dives. In 1972, I also directed the 5th International Underwater Physiology Symposium on Grand Bahama, Freeport.

In 1980, I initiated the Divers Alert Network (DAN) with grants from NIOSH and NOAA, but when grants ceased, developed a non-profit membership and insurance supported organization. An emergency and advisory telephone system was set up for recreational divers and considerable research was done on decompression sickness, diving accidents and fatalities, etc. Financial support increased at 20% per year to a $16 million company.

Soon the Duke facilities were inadequate and DAN moved to the University Tower in Durham, NC on the 13th Floor (free!). This too became inadequate and I found some land close by and proposed to build our own offices provided I could obtain a 100% mortgage. This was done and the Board named it the Peter B. Bennett

Center with a staff of about 80. In 1990, I formed International DAN with the help of Dr. Hiro Mano for DAN Japan and Dr. Alessandro Marroni for DAN Europe.

My other major work at Duke was to return to the High Pressure Nervous Syndrome and deep diving research. The US Navy, with the help of Cmdr. Bornmann had acquired two extra chambers to add to the six already at Duke. This meant the laboratory was now capable of reaching 109 ATA (3,600 ft) or 10,000 ft altitude. The signs and symptoms of HPNS were now clear and slower compression rates appeared to help. However, the US Navy in 1979 made a dive with 6 men to 1,800 ft with 3 ¾ days slow compression after 8 days at 650 ft but experienced severe HPNS. The US Navy then stopped all diving to no deeper than 1,000 ft as it is today.

However, from continuation of my basic research on pressure reversal and surface tension measurements in England, it seemed that the correct addition of a narcotic like nitrogen could possibly control the HPNS in helium deep diving.

So, in 1974 experiments at Duke compared a 33 min compression to 1,000 ft with either helium oxygen or TRIMIX i.e. helium oxygen and 10% nitrogen. The results supported the cellular membrane data and hypothesis that TRIMIX controlled HPNS signs and symptoms. Next was to plan and conduct project Atlantis to determine the effects of compression rate, percentage nitrogen in TRIMIX and to investigate the cause of dyspnea reported in very deep dives.

In 1979, for Atlantis 1, 3 volunteers were compressed in 12 hours, 30 minutes with TRIMIX at 5% nitrogen. HPNS was present with nausea, fatigue, poor sleep, marked tremors, large increase in EEG theta activity and performance decrements. Atlantis II in 1980 had the same compression rate but 10% nitrogen in the TRIMIX and this was very successful with good control of HPNS.

It was so successful that it was decided to compress to the eventual NIH grant proposed depth planned of 600 m (2,132 ft), which was a world record. Again, this was very successful but there were performance decrements apparently related to the 10% nitrogen or rate of compression. So in Atlantis III a year later, in 1981, compression was very much slower at 7 days, 9 hours but still with 10% nitrogen. There were no tremors, vomiting or EEG changes but the performance impairment was still present. Extensive research on the dyspnea reported in deep dives was carried out by Dr. Salzano, Dr. Moon, Dr. Camporesi and Dr. Stolp with arterial catheterization and hard work on an ergometer, which determined normal blood gases even though dyspnea was present.

It was planned then to further compress to 686 m (2,250 ft) for 24 hours. This record depth received great recognition around the world and a letter of congratulations from President Reagan.

The data pointed strongly that TRIMIX was very effective at controlling HPNS but the 10% nitrogen was too high and caused some narcosis. So, in Atlantis IV, in 1982, this was reduced to 5% but with the same slow compression to 650 m (2,132 ft). The results were very good but one diver became hypermanic and did not recover until the 1,000 ft depth during decompression.

During the early 1980's, the Germans had built a superb underwater diving simulator near Hamburg to develop the technology for welding pipelines at such great depths. I and the Duke team were invited to work with the GUSI team to permit TRIMIX use at depths to 600 m (2,132 ft). We used the Atlantis IV profile. From 1983-1986 there were 14 dives (300-600 m) with little or no HPNS, but much welding. From 1986-1990 there were 17 more deep TRIMIX 5% nitrogen dives to 450 m, with a total of 2,662 man days of saturation and 983 welding days with 13 divers.

The HPNS research stimulated James Cameron to develop a script for the movie "The Abyss" and asked me to review the script and be a technical advisor. It was filmed in South Carolina. This involved liquid breathing in rats developed at Duke by Dr. Hannes Klystra. In the movie, this was supposed to demonstrate protection from HPNS. In fact in liquid breathing studies in dogs by myself and Dr. Dave Harris, we proved that this was incorrect and HPNS was due to the pressure and not the helium.

In 2001, in other research in cooperation with Dr. Alessandro Marroni, we carried out human diving research to support the concept of a deep stop at half the depth during decompression as proposed originally by Haldane in 1906. The spinal cord tissue half time is only 12.5 minutes and it was considered this would help prevent spinal cord decompression sickness as occurs in recreational divers. Large numbers of dives with and without deep or shallow stops were made by Italian divers with Doppler bubble measurements.

The data supported the hypothesis and although controversial has been picked up by many dive computers and NAUI.

In 2006, another book was published with Dr. Frans Cronje and Dr. Earnest Campbell, "Assessment of Diving Medical Fitness for Scuba Divers and Instructors." At that time also, I took on the position of Executive Director of the UHMS until retirement this June 2014 and that is another story.

SESSION B

HBO_2 THERAPY MECHANISMS

B 13

ORAL PRESENTATION TIME: 1415 - 1427
POSTER PRESENTATION TIME: 1615 - 1645
RESIDENT COMPETITION: NO

CD34+/CD45-DIM STEM CELL MOBILIZATION BY HYPERBARIC OXYGEN CHANGES WITH OXYGEN DOSAGE

Heyboer M, Milovanova TN, Wojcik S, Grant W, Chin M, Hardy KR, Lambert DS, Logue C, Thom SR
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Introduction: Hyperbaric oxygen treatment mobilizes bone marrow derived-stem/progenitor cells by a free radical mediated mechanism. We hypothesized that there may be differences in mobilization efficiency based on exposure to different oxygen partial pressures.

Materials and Methods: Blood from twenty consecutive patients was obtained before and after the 1st, 10th and 20th treatment at two clinical centers using protocols involving exposures to oxygen at either 2.0 or 2.5 atmospheres absolute (ATA).

Results: Post-treatment values of CD34+ and CD45-dim leukocytes were always 2-fold greater than the pre-treatment values for both protocols. Values for those treated at 2.5 ATA were significantly greater than the 2.0 ATA treatment group by factors of 1.9 to 3-fold after the 10th and before and after the 20th treatments. Intracellular content of hypoxia inducible factors -1,-2, and -3, thioredoxin and poly-ADP-ribose polymerase assessed in permeabilized CD34+ cells with fluorophore-conjugated antibodies were twice as high in all post- versus pre-treatment samples with no significant differences between 2.0 and 2.5 ATA protocols.

Summary: We conclude that putative progenitor cell mobilization is higher with 2.5 versus 2.0 ATA treatments, and all newly mobilized cells exhibit higher concentrations of an array of regulatory proteins.

B 14

ORAL PRESENTATION TIME: 1427 - 1439
POSTER PRESENTATION TIME: 1615 - 1645
RESIDENT COMPETITION: NO

NRF2 ACTIVATION IN ASTROCYTES CONTRIBUTES TO SPINAL CORD ISCHEMIC TOLERANCE INDUCED BY HYPERBARIC OXYGEN PRECONDITIONING

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Introduction: In this study we investigated whether nuclear factor erythroid 2-related factor 2 (Nrf2) activation in astrocytes contributes to the neuroprotection induced by a single hyperbaric oxygen preconditioning (HBO-PC) against spinal cord ischemia/reperfusion (SCIR) injury. *In vivo*: At 24 h after a single HBO-PC at 2.5 atmospheres absolute for 90 min, the male ICR mice were subjected to SCIR injury by aortic cross-clamping surgery and observed for 48 h. HBO-PC significantly improved hindlimb motor function, reduced secondary spinal cord edema, ameliorated the reactivity of spinal motor-evoked potentials, and slowed down the process of apoptosis to exert neuroprotective effects against SCIR injury. At 12 h or 24 h after HBO-PC without aortic cross-clamping surgery, western blot, ELISA, realtime-PCR were used to detect the Nrf2 activity of spinal cord tissue, such as nuclear protein content, DNA binding activity, mRNA level, and the expression of downstream gene, such as glutamate-cysteine ligase, γ-glutamyltransferase, multidrug resistance protein 1, which are key proteins for intracellular glutathione synthesis and transit. The Nrf2 activity and downstream genes expression were all enhanced in normal spinal cord with HBP-PC. Moreover, glutathione content of spinal cord tissue with HBP-PC significantly increased at all time point after SCIR injury. *In vitro:* At 24 h after HBO-PC, the primary spinal astrocyte-neuron co-cultures from ICR mouse pups were subjected to oxygen-glucose deprivation (OGD) for 90 min to simulate the ischemia-reperfusion injury. HBO-PC significantly increased the survival rate of neurons and the glutathione content in culture medium, which was mainly released from asctrocytes. Moreover, the Nrf2 activity and downstream genes expression induced by HBO-PC were mainly enhanced in asctrocytes, but not in neurons.

Conclusion: Our findings demonstrated that spinal cord ischemic tolerance induced by HBO-PC may be mainly related to Nrf2 activation in astrocytes.

B 15

ORAL PRESENTATION TIME: 1439 - 1451
POSTER PRESENTATION TIME: 1615 - 1645
RESIDENT COMPETITION: YES

CLONIDINE DOES NOT PREVENT PULMONARY INJURY IN CONSCIOUS RATS EXPOSED TO HYPERBARIC OXYGEN

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Introduction/Background: Exposure to hyperbaric oxygen (HBO_2) at > 2 atmospheres absolute (ATA) can cause acute lung injury (ALI). Although the mechanisms have not been fully elucidated, excessive neuronal excitation and sympathetic outflow are contributors. The objective of this study was to determine whether use of clonidine hydrochloride to attenuate sympathetic outflow would increase seizure latency and prevent lung damage.

Methods: Sprague-Dawley rats were given an ip injection (1 cc) of either saline (control, n = 6) or (clonidine, 10-30 µg/kg, n = 6) 1 h before compression to 5 or 6 ATA. Time to seizure onset was recorded followed by post-mortem examination of the lungs to assess ALI: absent (0), mild (1), moderate (2), or severe (3). Bronchoalveolar lavage fluid (BALF) was collected to assay markers of pulmonary damage: lactate dehydrogenase (LDH), total protein, and nitrites and nitrates (NOx).

Results: The mean ± SD time of seizure onset did not differ between control and clonidine at 5 (86 ± 6 *vs.* 74 ± 11 min) or 6 ATA (8 ± 1 *vs.* 12 ± 8 min). The ALI score was generally moderate to severe independent of treatment or ATA. As such, the 5 and 6 ATA BALF data were pooled to assess differences in LDH, total protein and NOx levels. Similarly, there were no differences between control and clonidine for LDH (44 ± 25 *vs.* 60 ± 32 U/L), protein (1.3 ± 1.5 *vs.* 3.4 ± 1.9 mg/mL), or NOx levels (10.6 ± 5.3 *vs.* 13.7 ± 7.8 µM), respectively.

Summary and Conclusion: Clonidine administration (10-30 µg/kg) does not protect against seizures or pulmonary injury in rats exposed to HBO_2 at 5-6 ATA. These findings suggest that high sympathetic outflow does not shorten seizure latency or act as the sole driver of neurogenic pulmonary damage in HBO_2.

***Disclaimer:** "The views expressed in this article are those of the author(s) and do not necessarily reflect the official policy or position of the Department of the Navy, Department of Defense, or the United States Government."*

B 16

ORAL PRESENTATION TIME: 1451 - 1503
POSTER PRESENTATION TIME: 1615 - 1645
RESIDENT COMPETITION: YES

THE TOXIC EFFECTS OF HYPERBARIC OXYGEN IN S-NITROSOGLUTATHIONE REDUCTASE NULL MICE

Gasier HG, Demchenko IT, Kraft BD, Suliman HB, and Piantadosi CA
heath.gasier@dm.duke.edu

Introduction/Background: Oxygen toxicity is a known complication of hyperbaric oxygen exposure (HBO_2), especially above 3 atmospheres absolute (ATA), and can cause seizures and acute lung injury (ALI). The pathogenesis involves nitric oxide (NO)-mediated excitotoxicity, although precise molecular details remain elusive. Here, using mice deficient in S-nitrosoglutathione reductase (GSNOR), a key enzymatic regulator of S-nitrosylation, we tested whether excessive protein S-nitrosylation promotes HBO_2 damage in the brain and/or lungs.

Methods: Wild type (WT, $n = 8$) and GSNOR -/- ($n = 8$) mice were exposed to HBO_2 at 4 ATA for 100 minutes and monitored for neuro-excitation (e.g., grooming, twitching, convulsions, seizures). After exposure, the left lung was inflation-fixed with buffered formalin, and paraffin-embedded. H&E-stained sections were assigned an ALI score by a blinded observer for extent (0-4) X severity (0-3) of ALI using light microscopy. Bronchoalveolar lavage fluid (BALF) collected from the contralateral lung was assayed for lactate dehydrogenase (LDH), total protein, and nitrites/nitrates (NOx) levels.

Results: The number of seizure signs during the 100 minute exposure was similar between groups. The ALI score (mean ± SD) was also similar (WT, 9.5 ± 0.5 and GSNOR -/-, 10.0 ± 0.5). BALF LDH activity was significantly higher in WT (30 ± 8 U/L) compared to GSNOR -/- (21 ± 5 U/L) mice ($P = 0.02$). BALF total protein (WT, 1.3 ± 1.7 mg/mL *vs.* GSNOR -/-, 0.3 ± 0.1 mg/mL) and lung NOx levels (WT, 15 ± 6 µM *vs.* GSNOR -/-, 20 ± 11 µM) did not differ significantly between strains.

Summary and Conclusion: In mice with unregulated protein S-nitrosylation, we found no differences in excitotoxicity or ALI in extreme HBO_2. These data suggest that widespread protein S-nitrosylation does not significantly affect HBO_2-induced seizure latency or ALI, although other compensatory denitrosylases cannot be excluded.

Disclaimer: *"The views expressed in this article are those of the author(s) and do not necessarily reflect the official policy or position of the Department of the Navy, Department of Defense, or the United States Government."*

B 17

ORAL PRESENTATION TIME: 1503 - 1515
POSTER PRESENTATION TIME: 1615 - 1645
RESIDENT COMPETITION: NO

HYPERBARIC OXYGEN THERAPY INCREASES INSULIN SENSITIVITY IN OVERWEIGHT MEN WITH AND WITHOUT TYPE 2 DIABETES

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Introduction: It has been observed that patients with diabetes may experience a fall in their blood glucose levels during hyperbaric oxygen treatment (HBOT). For patients with type 2 diabetes (T2DM), we recently showed that insulin sensitivity was increased during HBOT. The aims of this study were to investigate whether this occurs in a non-patient population with and without T2DM, along with the mechanism of this effect.

Methods: 19 overweight and obese male participants were recruited from the community – 11 without and 8 with T2DM. Insulin sensitivity was assessed by hyperinsulinemic euglycemic clamp at baseline and during the third HBOT session. Fasting serum and adipose tissue samples were collected at baseline and immediately following 4 HBOT sessions. Additional fasting serum samples were collected during the first HBOT at 0, 60 and 120 minutes, and 24-hours after the last HBOT.

Results: In response to HBOT, insulin sensitivity was increased by 29±32% in those without (n=10, p=0.01), and by 57±66% in those with T2DM (n=7, p=0.04). This increase was maintained for 30-minutes after exit from the hyperbaric chamber. Reduced serum inflammatory markers MCP-1 and TNF-α were observed after HBOT, whereas IL-6 was increased in individuals without diabetes only and this correlated with the increase in insulin sensitivity (r^2=.72, p=0.004).

Conclusion: Insulin sensitivity was increased following HBOT in participants with and without T2DM. After exit from the hyperbaric chamber, this increase was maintained for at least 30-minutes. Changes in inflammatory cytokines may partly explain this effect.

B 18

ORAL PRESENTATION TIME: 1515 - 1527
POSTER PRESENTATION TIME: 1615 - 1645
RESIDENT COMPETITION: YES

ALTERNATIVE ACTIVATION OF ANTI-INFLAMMATORY MACROPHAGES IN THE LUNG BY HYPERBARIC OXYGEN DURING S.AUREUS SEPSIS IN MICE

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Introduction/Background: Hyperbaric oxygen therapy (HBO_2) has been reported to affect inflammatory cytokines such as TNFα and HO-1 in sepsis-related acute lung injury (ALI), by unknown mechanisms. Here we tested the hypothesis that HBO_2 induces a pulmonary anti-inflammatory response to sepsis by modulating alveolar macrophage (AM) phenotype expression.

Materials and Methods: To study the effect of HBO_2 on lung parenchyma during murine sepsis, C57BL/6 mice were divided into four groups: (i) control, (ii) untreated sepsis, (iii) HBO_2-treated sepsis, and (iv) HBO_2 control. Sepsis was induced by intra-peritoneal (IP) implantation of a *S. aureus* ($1x10^8$ cfu)-impregnated fibrin clot. HBO_2 (2.5 ATA) was administered at 6, 24, and 48 hours. Lungs from each group were harvested immediately following each HBO_2 treatment (n=3-4 per time point per group). ALI was quantified by bronchoalveolar lavage (BAL). Western blot and real time PCR were performed on whole lung homogenates at each time point. Immunohistochemistry and fluorescence microscopy were used to quantify M1 and M2 macrophage phenotypes.

Results: Septic mice treated with HBO_2 had decreased BAL fluid cell counts and LDH compared with untreated mice. HBO_2 therapy reduced lung TNFα and IL-1β protein, and increased IL-10 and HO-1 protein expression at 24 and 48 hours post-inoculation. HO-1 and IL-10 localized strongly to macrophages and to bronchial epithelium in all HBO_2-exposed groups. The ratio of alternatively activated anti-inflammatory (M2) to pro-inflammatory (M1) alveolar macrophages was significantly increased at 24 hours in HBO_2-treated sepsis compared to untreated sepsis group (14.2 vs. 2.7 respectively; $p<0.001$).

Summary/Conclusions: In the sepsis murine lung, HBO_2 blocks TNFα and IL-1β up-regulation and induces IL-10 and HO-1 expression in alveolar macrophages while simultaneously increasing the differential expression of macrophages with an M2 phenotype. HBO_2-mediated alternative activation of alveolar macrophages may account for an anti-inflammatory effect of HBO_2 in the lung during sepsis.

B 19

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1615 - 1645
RESIDENT COMPETITION: YES

THE TEMPORALLY SPECIFIC APPLICATION OF HBOT DURING DIGIT REGENERATION

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Introduction/Background: Limb amputation has a profound impact on an individual's productivity, vocation options and independence. One out of every 200 Americans is an amputee, and this number is expected to double in the next 40 years as a result of an increase in amputations secondary to vascular disease. In rodents, distal digit tip amputation results in regeneration of the digit tip, defined as three distinct steps: 1) wound healing and bone degradation, 2) formation of the blastema, and 3) differentiation of the blastema into bone and tissue. We have recently shown that the changing oxygen microenvironment of the regenerating digit is a dynamic event that is able to influence the regenerative process. The objective of this study is to establish the temporally specific effects of HBOT during digit regeneration in mice. Our hypothesis is that HBOT has differential effects when applied during temporally specific time points in digit regeneration.

Materials and Methods: Female, outbred CD-1 mice were amputated at the distal P3 level. HBOT treatment was applied at 2.4 ATA for 90 minutes once daily for two days immediately after amputation, during blastema formation, and during bone formation. Bone volume changes were tracked using micro-CT. Matrix evaluation utilized picrosirius red staining. Gene expression was analyzed using immunohistochemistry.

Results: Our data show that amputated digits treated with HBOT during different regenerative time points after amputation fully regenerate. A limited application of HBOT precipitates a negative, positive, and neutral affect on digit regeneration, dependent upon the stage of regeneration.

Summary/Conclusions: Our findings strongly support that oxygen is able to act as a primary signaling event to influence bone regeneration *in vivo*.

B 20

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1615 - 1645
RESIDENT COMPETITION: NO

HYPERBARIC OXYGEN THERAPY AND CLOSED IRRIGATION WITH OZONE NANO-BUBBLE WATER FOR BONE AND JOINT INFECTION

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Introduction: At present time, various antibiotics have been developed, but for bone and joint infection, suppurative osteomyelitis especially has still up to now been very difficult to cure. If not treated at the initial treatment for infectious arthritis or acute osteomyelitis, infection will spread throughout the bone, many patients are annoyed by the recurrence of chronic osteomyelitis. Moreover, an increase of multiple resistance bacteria, opportunistic infection and traumatic osteomyelitis make it very complex to treat. Since 1981, many patients with bone and/or joint infection were treated using hyperbaric oxygen therapy (HBO) and closed irrigation suction therapy. Recently we use “ozone nano-bubble water” in the irrigation resulting very favorably.

Method: All cases had both antibiotics and HBO. Debridement of synovium, curation of sequestrum, and closed irrigation suction therapy is carried out, if the case does not change or untoward badly. After the irrigation therapy, HBO is again carried out. Ozone nano-bubble water and HBO were used together in 21 cases of bone and joint infections.

Result and Conclusion: 20 out of 21 cases were successfully treated except for 1 case with infection of implants. The main feature of the “ozone nano-bubble” is that it has an excellent antiseptic capability against bacteria and is harmless to the human body. The ozone nano-bubble water may replace antibiotics to kill off bacteria in irrigation therapy.

B 21

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1615 - 1645
RESIDENT COMPETITION: YES

HYDROXOCOBALAMIN AND ASCORBIC ACID MIXTURE (B12r): A POTENTIAL ADJUVANT THERAPY IN THE SETTING OF CARBON MONOXIDE POISONING

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Introduction/Background: Carbon monoxide (CO) poisoning is a major public health problem worldwide. We evaluated the ability of a hydroxocobalamin/ascorbic acid mixture ("$B12_r$") to reduce the half-life ($t_{1/2}$) of carboxyhemoglobin (HbCO) by converting CO into carbon dioxide (CO_2) in blood.

Materials and Methods: A closed-loop artificial circulation system using a hollow-fiber membrane oxygenator circulated fresh whole human blood with real-time monitoring of the out-flow gas from the oxygenator. An HbCO concentration of 50% was achieved and pre-selected concentrations of the B12r solution were injected into the circulating blood. Pre and Post samples were drawn and analyzed by co-oximetry (Radiometer Copenhagen, ABL 825). The %HbCO and %HbO_2 of circulating blood were analyzed in real-time using Raman spectroscopy. ^{13}C labeled CO (Cambridge Isotope Laboratories) was used and the $^{13}CO_2/^{12}CO_2$ ratio was examined using an infrared spectral analyzer. Adult male Long-Evans rats were exposed to CO and then injected with either normal saline or $B12_r$. Pre and Post injection blood samples were analyzed by co-oximetry as above.

Results: $B12_r$ injection resulted in a five-fold increase in the gas-out concentration of CO_2 compared with controls. There was a 16.7% increase in the $^{13}CO_2/^{12}CO_2$ ratio over baseline. RR analysis showed that the antidote reduced the $t_{1/2}$ of HbCO in our system from 43 minutes to 19 minutes. Blood-gas data showed mean pH of 7.29 and pCO2 of 23.9 in placebo rats, versus pH 7.44 and pCO2 31.8 in B12r treated rats.

Summary/Conclusions: These data indicate that the mixture of hydroxocobalamin and ascorbic acid in blood containing carboxyhemoglobin is capable of converting CO to CO_2. The findings support the potential use of an injectable mixture of hydroxocobalamin and ascorbic acid as an alternative or complement to hyperbaric oxygen therapy in the setting of CO poisoning.

B 22

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: WITHDREW
RESIDENT COMPETITION: NO

HYPERBARIC OXYGEN THERAPY IN OCULAR DISEASE

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WITHDREW

B 23

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1615 - 1645
RESIDENT COMPETITION: YES

A TALE OF AUDIOGRAMS: IMPROVEMENT OF IDIOPATHIC SUDDEN SENSORINEURAL HEARING LOSS IN A PATIENT WITH PRE-EXISTING HEARING LOSS

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Introduction/Background: Idiopathic Sudden Sensorineural Hearing Loss (ISSHL) is the newest UHMS approved indication for Hyperbaric Oxygen Therapy (HBO_2). We present a successful treatment case of ISSHL with audiograms prior to hearing-loss, and after treatment with HBO_2.

Methods: A 79 year old male with longstanding bilateral high frequency hearing loss from artillery fire presented 12 days after developing low frequency ISSHL in the right ear. Notably, the exact degree of ISSHL could be calculated, as his baseline was documented in an audiogram a year prior. The degree of ISSHL was profound at 60 db, 70 db, 65 db, 45 db over those 4 continuous frequencies. He was unable to hear conversational speech. The patient had been given oral steroid therapy for the preceding 12 days without improvement. The steroids were continued and on day 13, HBO_2 commenced at 2 ATA for 2 hours daily.

Results: Despite starting HBO2 one day shy of the 14 day UHMS recommended window, the patient improved rapidly. Repeat audiogram after 9 treatments (Day 26) showed a residual hearing loss of 10db, 20 db, 30 db, 25 db compared to baseline over continuous frequencies, which was an improvement of 50 db, 50 db, 35 db, 20 db. After 20 treatments of HBO therapy (day 45), the audiogram showed a remaining hearing loss of 10 db, 15 db, 25 db, 20 db compared to baseline, an improvement of 50 db, 55 db, 40 db, 25 db.

Conclusions: This case allows us to accurately compare the exact degree of ISSHL in a patient with pre-existing hearing loss documented by a baseline audiogram, as well as substantial improvement with HBO_2 therapy. The patient's response to HBO2 therapy and steroids, despite starting him at the upper edge of the UHMS recommended 14-day window, suggests possible benefit in extending the HBO_2 therapeutic window, perhaps as much as that recommended by the American Academy of Otolaryngology (3 months).

B 24

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1615 - 1645
RESIDENT COMPETITION: YES

FLAP PRECONDITIONING WITH ADIPOSE DERIVED STEM CELLS AND HYPERBARIC OXYGEN TREATMENT: A GUINEA PIG MODEL

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Introduction/Background: Chronic wound care require consistent management ranging from excision and debridement to timely wound dressing changes. In the case of non-healing chronic wounds, supplementary surgical management relies on skin grafting as well as tissue flap reconstruction. Ultimately, tissue flap success rates remain susceptible to potential postoperative risks, including hypoperfusion and tissue ischaemia. As a result, adjunctive therapies that may improve tissue flap survival must be explored. Thus, we propose a small animal model to explore the role of adipose-derived stem cells (ADSCs) and hyperbaric oxygen treatment (HBOT) in tissue flap reconstruction while quantifying their effects on flap survival. Additionally, research findings stand to identify the most favorable time for preoperative delivery of these adjunctive therapies.

Methods and Materials: This prospective randomized control trial consists of thirty-six guinea pigs that are assigned to one of two groups. The first group compares saline injections against ADSC injections and the second group compares saline injections against ADSC injections with four consecutive days of HBOT. Following preconditioning on the fourth day of HBOT, a pedicled flap was elevated to assess the postoperative tissue survival.

Results: Clinical appearance of the skin flap will be assessed visually to detect signs of venous or arterial compromise. Serial examinations of the flap will monitor the consistency, color, capillary refill, vascularity as well as temperature of the flap. Biochemical analysis will consist of measuring HSP-70 levels while assessing the degree of tissue necrosis using a TUNEL apoptosis detection kit. Results are pending and will be presented at the UHMS meeting.

Summary/Conclusions: The objective of this research project is to elucidate the capacity of preconditioning to stimulate proliferation and differentiation of ADSCs. Furthermore, we hypothesize that HBO pre-treatment will improve the flap survival rate by stimulating heat shock proteins and preconditioning the flap itself.

B 25

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1615 - 1645
RESIDENT COMPETITION: YES

HYPERBARIC OXYGEN THERAPY FOR AN AIR EMBOLISM FROM AN ATRIAL-ESOPHAGEAL FISTULA

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Introduction: Atrial-esophageal fistula (AEF) with esophageal content embolization may complicate cardiac radio-frequency catheter ablation.

Case: A 46 year-old male with fever, right-sided neurologic deficits and ataxia one week after his second radiofrequency ablation was admitted to an outside hospital. Although initially diagnosed with meningitis, left atrial air on chest CT suggested cerebral air embolization via left atrial to esophageal fistula. After ground transport to Duke, transthoracic echocardiography supported the diagnosis. Eighteen hours after presentation the atrial and esophageal defects were surgically oversewn via right thoracotomy under oxygen, propofol, fentanyl, and relaxant anesthesia. Pre-hyperbaric therapy he was tracheally intubated, unable to follow commands or move his right arm. Twenty-eight hours after presentation he received five 2.8 ATA hyperbaric treatments resulting in neurological improvement plateauing with right upper extremity weakness that progressed to complete recovery at his two-month follow-up visit.

Discussion: Atrial-esophageal fistulas are rare (<1% of cases), often fatal complications of radio-frequency ablations. Thrombi, air or food emboli can cause sudden neurologic symptoms, chest pain, fever or sepsis, usually a median of 17 days (range 3-38) after ablation. Diagnosis may be delayed by clinical variability, delayed time course, and physician unfamiliarity. Brain or chest imaging may not be diagnostic, therefore, a history of recent ablation is key. Treatment is surgical repair or esophageal stenting. Although indicated, few patients receive hyperbaric oxygen. While early compression is optimal, delayed treatment may still be beneficial. Patients should receive 100% oxygen until compression. U.S. Navy Treatment Table 5 or 6, compression with 100% oxygen at 2-2.8 ATA, is a starting table with time extensions added depending on symptom improvement. Additional hyperbaric oxygen treatments are given until improvement reaches a plateau.

Conclusions: Hyperbaric oxygen is indicated after repair of atrial-esophageal fistula in patients with focal neurologic symptoms.

PLENARY: *The Placebo Effect & Hyperbaric Medicine*

Michael Bennett, MD, FUHM

1630 - 1730

About the Lecturer:
Associate Professor Michael Bennett MB BS, FANZCA, MM(Clin Epi), DipDHM, MD

Mike Bennett is an anaesthetist who was appointed director of the Department of Diving and Hyperbaric Medicine at Prince Henry Hospital in 1994 and continues to work in the field, now at POWH. He has been the convenor of the Australia and New Zealand Hyperbaric Medicine Group Introductory Course in Diving and Hyperbaric Medicine from inception in 1999 and is an executive member of the College SIG. He has published widely on the evidence–basis of hyperbaric medicine and remains a keen diver.

About the Lecture:
The Placebo Effect And Hyperbaric Medicine
Deeper Into Placebo, Nocebo And The Hawthorne Effect

Introduction: Randomised controlled trials (RCTs) have many advantages when they are well-conducted. Most importantly they eliminate selection bias (to each arm of study) and eliminate conscious or subconscious bias by investigators or patients. In addition, random allocation is an assumption for common statistical methods and blinding to treatment allocation will ensure any effect of participation does not bias the result. In such trials, clinically important differences between treatment groups are either due to treatment effects or the results of random chance. The probability of a given result being due to chance is estimated by statistical testing – the examination of which is the basis for drawing conclusions about the effectiveness of treatment. For RCTs that are less well designed, placebo, nocebo and Hawthorne effects may be problematic and render the interpretation of any findings problematic. This presentation explores these effects.

Placebo: A term derived from **t**he Latin: placēbō, "I shall please". It has been defined as "a simulated or otherwise medically ineffectual treatment for a disease or other medical condition intended to deceive the recipient." Sometimes patients given a placebo treatment will have a perceived or actual improvement in a medical condition, commonly called the **placebo effect**. Placebos have a venerable history. In the 18th century they were the norm, and defined as a "commonplace method or medicine". By 1903, the ethics of the deliberate use of a placebo were being deeply questioned. Richard Cabot said that he was brought up to use placebos, but concluded "I have not yet found any case in which a lie does not do more harm than good". It is important to realise that placebos extend beyond dummy medications. In 1961, Beecher concluded that surgeons he categorized as enthusiasts relieved their patients' chest pain and heart problems more than skeptic surgeons. It was also in the 1960s that placebos found their place in controlled trials prior to the approval of new treatments. A sham HBOT fits the definition of a placebo – but only if we accept that it has *no intrinsic therapeutic action* for the condition under study. This acceptance has become contentious.

Placebo mechanisms: There remains a lot we cannot adequately explain about the placebo effect. The placebo response can be seen as simply the patient response that cannot be attributed to an investigational intervention. There are, however, multiple possible components of a measured placebo effect, including altered levels of hormones or endorphins, expectancy effects by patient and physician, regression to the mean and of course, flawed trial methodology. Sorting this out in the individual case can be very challenging.

Hawthorne effect: A form of reactivity whereby subjects improve or modify an aspect of their behaviour in response to the fact that they know that they are being studied, not in response to any particular experimental manipulation. The original studies investigated productivity in response to changes in the workplace –whatever changes were made always resulted in improvements that then faded away (e.g. in response to both increasing and decreasing illumination). This concept has been extended to treatment response in clinical trials. The mechanism is unclear BUT, if there is a demonstrable benefit from participating in clinical research, *for whatever reason*, then this has implications for good clinical practice and for improving care. The implications for HBOT research are that the Hawthorne Effect should not affect assessment of the difference between intervention and control. It may however, result in an inflated estimate of effect size in routine clinical settings by over-estimating the response in both groups. If a treatment is equally ineffective as the control, then both groups may improve, but *if a trial is unblinded, the Hawthorne effect may bias the results in favour of the 'active' treatment arm – whether or not it is 'truly' effective*.

Conclusions: Only RCTs can reliably infer causation, and when attempting to prove causation, there is no substitute for rigorous trial methodology. When planning a trial, always consider alternative explanations for both anticipated and unanticipated results AND modify trial procedures to minimise any misinterpretation before you start. When interpreting trial findings, use Occam's razor (*lex parsimoniae*) as a guiding principle.

FRIDAY
JUNE 20

SESSIONS
C & D

SESSION C
CLINICAL HBO_2 AND WOUND HEALING

C 26

ORAL PRESENTATION TIME: 0800 - 0812
POSTER PRESENTATION TIME: 0900 - 0930
RESIDENT COMPETITION: NO

PROGRESS OF THE BRAIN INJURY AND MECHANISMS OF ACTION OF HYPERBARIC OXYGEN (HBO_2) FOR PERSISTENT POST-CONCUSSIVE SYMPTOMS AFTER MILD TRAUMATIC BRAIN INJURY (BIMA) STUDY

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Introduction/Background: The BIMA study, sponsored by the Department of Defense (DoD), presents a unique opportunity to gain information about hyperbaric oxygen (HBO_2) mechanisms of action. A randomized, double-blind, sham-controlled clinical trial, BIMA is differentiated from recently published DoD-sponsored HBO_2 studies because of its longer duration of follow-up (12 months) and its ambitious assessment battery allowing for investigation of symptomatic as well as functional responses to HBO_2.

Materials/Methods: BIMA initiated September 2012 and will complete enrollment May 2014. Randomized Active Duty military personnel and Veterans receive HBO_2 at 1.5 ATA or sham chamber sessions at 1.2 ATA, air, for 60 minutes daily for 40 sessions. Outcome measures include neuropsychological, neuroimaging (MRI, fMRI, MR Spectroscopy, DTI; CT perfusion), neurological, vestibular, autonomic function, EEG, and visual systems domains (e.g. static/dynamic visual acuity, eyetracking, fundus photography) evaluated at baseline, 13 weeks, and 6 months with only computerized self-report questionnaires performed at 12 months.

Results: As of March 06, 2014 147 participants have been enrolled and 56 (target = 72) randomized. Characteristics include: Median age 32 years (range 21 - 49), 98% male, 84% Caucasian, 45% diagnosed PTSD, 29% with most recent qualifying injury 3 months to 1 year prior to enrollment, 79% $\geq$1 blast injury, and 71% with multiple injuries. Forty have completed chamber sessions and the first follow-up visit at 13 weeks, 24 have completed the 6-month follow-up visit, and 10 have completed the final 12-month follow-up visit. Of those who have completed chamber sessions, 83% (33/40) have completed 40 chamber sessions and 95% have completed $\geq$20. Adherence to follow-up visits is high with 97% completing all expected visits.

Summary/Conclusions: BIMA will provide detailed characterization of potential outcome measures for persistent post concussive symptoms following mTBI. Independent of a therapeutic role of HBO_2, the information from BIMA will aid understanding of mTBI.

C 27

ORAL PRESENTATION TIME: 0800 - 0812
POSTER PRESENTATION TIME: 0900 - 0930
RESIDENT COMPETITION: NO

NEUROLOGICAL EVALUATIONS WITHIN THE BRAIN INJURY AND MECHANISMS OF ACTION OF HYPERBARIC OXYGEN (HBO_2) FOR PERSISTENT POST-CONCUSSIVE SYMPTOMS AFTER MILD TRAUMATIC BRAIN INJURY (MTBI) STUDY (BIMA)

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Introduction/Background: BIMA is a Department of Defense sponsored randomized, double-blind, sham-controlled clinical trial to investigate symptomatic as well as functional responses to HBO_2 in a military population with persistent post concussive symptoms following mTBI. A battery of neurological assessments is under evaluation as potential outcome measures in this population.

Materials and Methods: BIMA initiated September 2012 and will complete enrollment May 2014. Randomized participants receive hyperbaric oxygen (HBO_2) 1.5 atm abs or sham chamber sessions at 1.2 ATA, air, for 60 minutes daily for 40 sessions. A comprehensive neurological exam, oculomotor exam, balance testing (Berg Balance Scale-BBS, Romberg Test-RT), Sharpened Romberg Test -SRT), Romberg Test (RT), and olfactory function (Brief Smell Identification test-BSIT) was performed at baseline. Testing is repeated at 13 weeks and 6 months post-randomization.

Results: Fifty-six participants completed baseline exams. Participant characteristics included: Median age 32 years (range 21, 49), 98% male, 84% Caucasian, 45% diagnosed PTSD, 29% with most recent qualifying injury 3 months-1 year prior to enrollment, 79% ≥1 blast injury, and 71% with multiple injuries. On neurological exam 12% presented with tremor, abnormal facial sensation (18%), and abnormal tandem gait (12%). On oculomotor exam 79% had accommodative insufficiency with an average accommodative break of 24 cm (range 9-80 cm). 89% scored ≥ 55 with no participant scoring < 50 on the BBS. 46% scored < 30 seconds on the best trial of the SRT. RT was abnormal in 9%. On the BSIT, 16% of participants scored ≤ 9 (out of 12), about twice what is expected in a normal population.

Summary/Conclusions: In BIMA participants with mTBI sequelae, the neurological examination found abnormalities across a range of testing.

C 28

ORAL PRESENTATION TIME: 0800 - 0812
POSTER PRESENTATION TIME: 0900 - 0930
RESIDENT COMPETITION: NO

CHARACTERIZATION OF BASELINE EEG ABNORMALITIES IN THE BRAIN INJURY AND MECHANISMS OF ACTION OF HYPERBARIC OXYGEN (HBO2) FOR PERSISTENT POST-CONCUSSIVE SYMPTOMS AFTER MILD TRAUMATIC BRAIN INJURY (mTBI) STUDY (BIMA)

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Introduction/Background: The Brain Injury and Mechanisms of Action of HBO_2 for Persistent Post-Concussive Symptoms after Mild Traumatic Brain Injury (BIMA) , sponsored by the Department of Defense (DoD) is a randomized, double-blind, sham-controlled trial of hyperbaric oxygen (HBO_2) in Servicemembers with persistent post-concussive symptoms following mild TBI, undergoing comprehensive assessments. There is scant literature about EEG findings in this population, so we will report baseline clinical electroencephalography (EEG) results.

Materials/Methods: BIMA initiated September 2012, and should complete enrollment by May 2014. Clinical EEG was assessed by 3 neurologists inspecting for both inctal and interictal epileptiform abnormalities, background periodic discharges, plus localized and generalized slow wave activity. Antidepressants were continued. We recommended that narcotics and benzodiazepines be withheld the day of the EEG. Those with EEG abnormalities were compared to those without EEG abnormalities to determine if co-variants influenced abnormalities.

Results: By March 06, 2014, 56 participants have had EEGs., The median age is 32 years (range 21, 49), 98% male, 29% sustained the most recent qualifying injury 3 months to 1 year prior to enrollment, 79% had at least one blast injury, and 71% had multiple injuries. None of the randomized participants had interictal epileptiform abnormalities, ictal abnormalities, or periodic discharges at baseline, while 2 (2%) and 9 (16%) of participants displayed either localized or generalized slowing of mild severity, respectively. It did not appear that concomitant antidepressant, and chronic narcotics and benzodiazepines (held on the day of the EEG) influenced results.

Summary/Conclusions: In this study of participants with sequelae following mTBI, the clinical EEG interpretation was abnormal in 20%, most commonly with generalized slowing. The use of concomitant antidepressants and chronic narcotics or benzodiazepines did not seem to influence these results, suggesting that generalized slowing may be due to mTBI-related brain injury.

C 29

ORAL PRESENTATION TIME: 0812 - 0824
POSTER PRESENTATION TIME: 0900 - 0930
RESIDENT COMPETITION: NO

A COMPOSITE OUTCOME MEASURE FOR MILD TRAUMATIC BRAIN INJURY IN A HYPERBARIC OXYGEN CLINICAL TRIAL

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Introduction: Recovery after mild traumatic brain injury (mTBI) is often measured by patient-reported symptoms, because neuropsychological testing (NPT) and neurological function are interpreted normal. We incorporated symptoms, NPT, and functional outcome into a composite score to quantify multidimensional change in a clinical trial of hyperbaric oxygen (HBO2) for persistent post-concussive symptoms (HOPPS).

Methods: We assigned HOPPS assessments to equal-weight categories. Symptom scores (NSI: dizziness, headaches, concentration, forgetfulness, slow thinking, fatigue, irritability) were totaled and divided by two. For NPT (Trails B, Stroop Color/Word, verbal fluency (D-KEFS), verbal learning (CVLT-II), visual-spatial memory (BVMT-R), procedural reaction time (ANAM)), participants received 1 point for test performance >1 standard deviation (SD) below the mean, >2SD below the mean (2), and >3SD below the mean (3). For functional outcome, grooved pegboard was scored like NPT. Sharpened Romberg (best of 4 attempts) was scored ≥30 seconds (0), 20-29 (1), 10-19 (2), 5-9 (3), 0-4 (5). Anxiety (BAI), depression (CES-D), and sleep (PSQI) were scored normal (0), mild (1), moderate (2), and severe (3). The composite score was the sum of scores from each domain.

Results: 72 participants enrolled (3 female, mean age 31 years, mean 3 lifetime concussion events, most recent mTBI 23 months prior to enrollment), and 64 had complete data at 13-week follow-up. Composite scores and total symptom scores were:

		Local Care (no chamber) (n=20)	HBO2 (1.5 ATA) (n=23)	Sham (1.2 ATA air) (n=21)
Composite	Baseline	15±8	17±9	18±7
	Follow-up	17±8	13±8	14±9
Total NSI Score	Baseline	32±15	33±17	34±17
	Follow-up	33±19	30±16	27±17

Conclusions: The local care group did not change. Chamber groups trended towards improvement without apparent discrimination by NSI score or our exploratory, unvalidated composite. These data suggest patient-reported symptoms may adequately reflect status change after mTBI.

C 30

ORAL PRESENTATION TIME: 0812 - 0824
POSTER PRESENTATION TIME: 0900 - 0930
RESIDENT COMPETITION: NO

PROCEDURAL REACTION TIME (ANAM) FOR MILD TRAUMATIC BRAIN INJURY IN A HYPERBARIC OXYGEN CLINICAL TRIAL

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Introduction: Simple Reaction Time (SRT) and Procedural Reaction Time (PRT) are speed-of-processing tasks in the Autom ated Neuropsychological Assessment Metrics (ANAM). We evaluated these in a rand omized, double-blind, sham-controlled clinical trial: "A Pilot Phase II Study of Hyperbaric Oxygen for Persistent Post -Concussive Symptoms After Mild Traum atic Brain Injury (HOPPS)."

Materials/Methods: Using the ANAM, we measured SRT and PRT throughput (correct responses per minute) at baseline, 6, and 13 weeks in Servicemembers with mTBI randomized to local care or 40 chamber sessions (sham-1.2 ATA air, hyperbaric oxygen-1.5 ATA O2). SRT and PRT scores were assessed for comparability among intervention groups at baseline using univariate ANOVA and across time with repeated measures methods.

Results: 72 participants with ongoing sym ptoms after mTBI enrolled in the study (3 fem ale, mean age 31 years, m ean 3 lifetime concuss ion events, most recent mTBI 23 months prior to enrollment). 67 had A NAM data at 6 weeks a nd 64 at 13 weeks. In the repeated m easures model, changes over tim e in SRT ($p=0.23$) or PRT ($p=0.17$) scores were not different am ong intervention groups.

Table 1. Mean [95% CI] SRT and PRT Throughput Standard Scores

	Interval	Local Care (no chamber)	HBO_2 (1.5 ATA)	Sham (1.2 ATA)	Total
PRT	Baseline	85[72,98]	79[64,94]	85[71,100]	83[75,91]
	6-weeks	76[61,90]	80[65,96]	87[73,100]	81[73,89]
	13-weeks	70[55,85]	81[66,97]	87[73,101]	80[71,88]
SRT	Baseline	86[74,97]	81[68,94]	87[76,99]	84[78,91]
	6-weeks	88[75,100]	90[77,102]	94[82,106]	91[84,97]
	13-weeks	81[68,94]	88[76,100]	79[65,92]	83[76,90]

Conclusions: SRT and PRT through put standard scores were comparable across groups at baseline. Across time, SRT scores did not change in the HBO_2 or sham groups and decreased slightly in the local care group. PRT throughput standard scores increased from baseline to m id-intervention and decreased from mid-intervention to post-intervention in all groups. There was no evidence that these changes across time differed among the HBO_2, sham, and local care groups

C 31

ORAL PRESENTATION TIME: 0824 - 0836
POSTER PRESENTATION TIME: 0900 - 0930
RESIDENT COMPETITION: NO

THE EFFECT OF HYPERBARIC OXYGEN TREATMENT ON RESTING STATE NETWORKS

Allen M, Shimony JS, Davidson JA, Benzaquen M, Rutlin J, Leuthardt E, Ances B, Benzinger T, Brier M, Davidson JD
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Introduction / Background: Resting-state functional magnetic resonance imaging (rsfMRI) has been used to reliably identify and study resting state networks (RSN) in the brain. The purpose of this project was to evaluate if Hyperbaric Oxygen (HBO) treatment can help patients with chronic cerebral small vessel disease (CSVD) by measuring changes in connectivity of RSN.

Materials and Methods: 20 patients >50 years of age with chronic CSVD were recruited from the community. Patients were scanned using rsfMRI before and approximately 4 weeks after they were treated with HBO therapy. Subjects were treated in Sechrist Monoplace Hyperbaric Chambers at a pressure of 2 atmospheres absolute for 45 minutes using 100% oxygen. Subjects were given 10 treatments over a span of 2 weeks (5 treatments per week). 20 age-matched controls and 17 young adult healthy controls were selected from other ongoing studies at our institute. rsfMRI pre-processing was performed using standard methods. 36 regions of interest associated with the following RSN were selected for analysis: Default Mode (DMN), Dorsal Attention (DAN), Control (CON), Salience (SAL), and Somatomotor (SMN). The correlation matrix between all regions was calculated and transformed using the Fisher z-transform to obtain normal distributions. The internetwork and intra-network connectivity for these five RSN was measured and compared across groups.

Results: The difference between intra-network connectivity of the young control group and the healthy elderly controls was small. The connectivity of all five RSNs decreased significantly between the healthy elderly controls and the elderly patients with CSVD. The connectivity in this group of patients shows improvement after HBO therapy specifically in the Dorsal Attention Network.

Summary / Conclusion: The current study provides preliminary evidence that HBO treatment can be used to improve RSN connectivity in the DAN network in patients with CSVD.

C 32

ORAL PRESENTATION TIME: 0836 - 0848
POSTER PRESENTATION TIME: 0900 - 0930
RESIDENT COMPETITION: NO

PHASE 2 CLINICAL TRIAL USING HYPERBARIC OXYGEN, RADIATION AND CHEMOTHERAPY FOR GLIOBLASTOMA TREATMENT

Duic JP, Grewal J, Gorenstein S, Haas J, Demaria T, Tessler L, Rak R, Almaliah M, McConie K, Prabhu RK, Trojanowski J, Namoca M
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Tumor hypoxia confers resistance to radiation and chemotherapy. Hyperbaric hyperoxygenation (HBO) may increase sensitivity to treatment. Glioblastomas are among the most hypoxic tumors. Chemoradiation with temozolomide followed by monthly temozolomide defines standard of care for newly diagnosed glioblastomas. We are conducting a single-arm, open label, pilot study adding HBO to standard therapy for adults with newly diagnosed glioblastomas. The study was approved by the institutional IRB.

After providing informed consent, subjects begin hyperbaric-chemoradiation therapy (HCRT). HBO, 30 minutes at 3 atm, is delivered before each daily radiation treatment for 30 sessions. Subjects receive radiation within 15 minutes of decompression and take daily temozolomide. After HCRT, subjects continue with standard therapy.

We have enrolled (32) subjects: 19 males (59.4%) and 13 females (40.6%), median age 62.5 yrs (range 28-80). 28/32 started and 25/28 (89.3%) completed HCRT. 3/28 terminated HCRT early: one withdrew consent; one developed spinal leptomeningeal metastases (unrelated to study) and was removed; one unexpectedly died at his residential facility--the cause of death was undetermined.

Of the 25 who completed HCRT, one subject was removed for persistent thrombocytopenia, another was lost to follow-up, and one subject developed temozolomide-hypersensitivity and could not continue.

23/25 subjects are evaluable per protocol. MS is 14.9 mos (7.7 – 37.5). Two subjects are alive at 13.7 mos and 31.9 mos. OS-12, 18 and 24 mos: 82.6%, 43.4% and 34.8%.

HCRT is well tolerated. No subjects terminated study intervention early due to study-related toxicity. AE's included: mild-moderate tympanic barotrauma in 4 subjects, and focal seizures in 2 subjects, one with subsequent generalization. Except for the one death, we had no unanticipated significant or serious events that were not covered by the informed consent document.

HCRT is feasible. The study is not powered to demonstrate improvement in survival over current therapy. Larger randomized studies are needed.

C 33

ORAL PRESENTATION TIME: 0848 - 0900
POSTER PRESENTATION TIME: 0900 - 0930
RESIDENT COMPETITION: NO

TNF-ALPHA AS A BIOMARKER FOR NEUROLOGICAL SEVERITY IN ACUTE CARBON MONOXIDE (CO) POISONING

Vezzani G, Abbati E, Caberti L, Cantadori L, Galli E, Manelli D, Mordacci M, Reverberi C, Spigolon A, Malpeli M, Dazzi D, Pizzola A, Mangar D, Camporesi EM
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Severe CO poisoning results in cardiac and brain complications which require Hyperbaric Oxygen (HBO) therapy to reduce sequelae (Weaver 2000). CO-induced myocardial damage can be monitored by measuring circulating Atrial Natriuretic Peptide (ANP) levels. On the other hand, neurological injury and sequential morbidity could not be predicted for lack of specific biologic markers.

We measured several biomarkers in all acutely intoxicated patients admitted for HBO to the principal referral facility in Northern Italy, (Vaio Hospital; Parma, Italy)during 3 winter months in 2013. Venous blood samples (10 ml) were obtained from 30 patients(standing research protocol) upon admission to the facility and after completion of the first HBO treatment. Seven healthy adult volunteers (Controls) were also exposed to the same HBO treatment and provided blood samples after written consent, before and after the same HBO exposure. Standard blood gas data and HbCO were obtained from the samples; additionally measured serum biomarkers comprised: IL-6,8,and 10; C-Reactive Protein (CRP), TNF-alpha, cerebral enolase and S100B protein. Neurological evaluations were obtained on arrival and at 10,20 and 30 days. Intubated comatose patients were excluded.

Twenty patients never lost consciousness after rescue; but ten of the admitted patients suffered transient loss of consciousness(LOC). Neurological symptoms observed at the time of starting HBO treatment comprised confusionin 7 and persistent headacke in one. All symptoms were resolved after completing one HBO cycle and none of the neurological symptoms were present at follow-up.

Most of the assayed biomarkers showed no changes after the HBO treatment, albeit they differed from Controls. Significant changes (before vs. after HBO) were noted for two: IL-10 and TNF-alpha, indicating substantially higher starting levels than Controls before HBO, and a significant reduction after completing HBO, when all 30 patient data were pooled ($p<0.029$ by Wicoxon two tailed signed-rank test). When patients were separated (10 vs. 20) as per LOC, all the significance of TNF-alpha and IL-10 values remained high for the 10 who suffered from LOC, but disappeared for the 20 without LOC. We suggest that high values of TNF after HBO in CO patients might provide indication for additional HBO treatments.

C 34

ORAL PRESENTATION TIME: 1000 - 1012
POSTER PRESENTATION TIME: 0900 - 0930
RESIDENT COMPETITION: NO

OUTCOME, COST AND MORTALITY IN WAGNER GRADE 3 DIABETIC FOOT ULCER (DFU) PATIENTS COMPLETING HYPERBARIC OXYGEN THERAPY (HBOT)

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Introduction: Between August 2005 – June 2013, 96 patients with Wagner Grade 3 or 4 diabetic foot ulcer (DFU) completed 104 series of hyperbaric oxygen therapy (HBOT) while following a limb salvage pathway at Intermountain Dixie Regional Medical Center. Results: The average number of treatments was 27 per series having an estimated average cost of $13,000. Eighty-six of 96 (89.5%) patients healed or had significant improvement at the end of HBOT. One has remained unchanged. Eight patients had below knee (BK) amputations within one year after finishing HBOT, and one had an above knee amputation (AK). Average costs for a BK or AK admission at our hospital were $21,000 and $28,000 respectively.

Twenty-seven of the 96 patients (29%) were confirmed dead by June 2013; three in less than one year after HBOT, 6 in one year, 8 in two years, 5 in years 3 and 4, 3 at year 5 and one each at years 6 and 7. Two patients were lost to long term follow-up. Causes of death were heart failure (7), myocardial infarction (9), renal failure (4), sepsis (4), cancer (2), and heatstroke (1). The number of patients treated vs. (deceased) by age group is: <60yrs 32(4); 60-69 27(6); 70-79 24(9); and >79 13(9).

Conclusions: Wagner Grade 3 or 4 DFU as well as BK/AK are associated with high 5-year mortality rate. Our limb salvage approach had an 89% success rate for avoiding BK/AK in these patients, but 29% were dead by the end of the study, which may underestimate the 5-year mortality. If the cost of the nine patients who had BK/AK amputations is added to the estimated average cost of HBOT, the average cost of utilizing HBOT for Grade 3 or 4 DFU for the entire group of 96 patients($15,041) remains less than the cost of a single hospitalization resulting in BK/AK amputation ($21,000-28,000).

C 35

ORAL PRESENTATION TIME: 1012 - 1024
POSTER PRESENTATION TIME: 0900 - 0930
RESIDENT COMPETITION: YES

GLYCOSYLATED HEMOGLOBIN AND HYPERBARIC OXYGEN-RELATED DIABETIC FOOT ULCER HEALING

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Introduction/Background: Medicaid and some Medicare fiscal intermediaries are denying HBO2 diabetic foot ulcer (DFU) patients if their glycosylated hemoglobin (HbA1c) is greater than 7%. This presentation will review and abstract the literature as it relates to DFU and wound healing.

Materials/Methods: We performed a PubMed search for: “diabetic foot ulcer” and “glycosylated hemoglobin.” We filtered the results to include clinical trials. In addition, we also looked for papers whose purpose was to associate HbA1c with wound healing.

Results: We scrutinized 16 peer-reviewed clinical trials found in the PubMed database. Thirteen were randomized controlled trials (RCT), 2 retrospective reviews, and 1 pooled analysis of 5 clinical trials. More than 2,000 patients are represented. The average HbA1c from the intervention side of the studies was 8.6% (7.5-11.3%, median of 8.2) and the control/sham side was 8.8% (8.0-10.9%, median of 8.4).

Summary/Conclusions: Seven studies made an attempt to associate HbA1c and wound healing. One retrospective cohort and 1 chart review series concluded that higher HbA1c levels were associated with a slower healing rate. However, 4 randomized controlled trials and 1 pooled analysis concluded that HbA1c was not a factor in wound healing through regression analysis. One retrospective review showed that a higher HbA1c in patients receiving HBO2 led to better wound outcomes. No RCT data shows HbA1c directly influences DFU healing. One RCT posits that healing time is predominantly dependent on etiological causes of DFU. While we try to optimize blood glucose control, there are many other factors that complicate DFU healing.

We conclude that the practice of denying adjunctive HBO2 with HbA1c >7% for DFU has no scientific support.

C 36

ORAL PRESENTATION TIME: 1024 - 1036
POSTER PRESENTATION TIME: 0900 - 0930
RESIDENT COMPETITION: YES

DELAYED VISUAL DISTURBANCES IN CARBON MONOXIDE POISONING: IDENTIFICATION AND EVALUATION

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Introduction/Background: Carbon monoxide (CO) poisoning may result in neurological and cognitive sequelae including visual problems, weeks, months, and years after initial poisoning. We performed neuro-optometric examinations in patients who reported vision-related changes or attention complaints during long-term follow-up evaluations after CO poisoning.

Materials/Methods: We performed a retrospective chart review of patients with CO poisoning that also had neuro-optometry evaluations between 08/28/2009 and 8/31/2013. Data collected include general demographics, symptomatic changes prompting neuro-optometric examination, and pathologic findings during this examination.

Results: We identified 43 CO-poisoned patients receiving neuro-optometry evaluation.

Demographics:	
Age (years)	41.8±14 (17-72)
Female (%)	60
Chronic Exposure (>24hrs)(%)	65
Time from Poisoning to exam (years)	2.4±1.7 (0.05-7.1)
Initial Presentation:	
CoHb (n=28)	16.9±9.9 (1.0-38.8)
LOC (%)	20.9 (Intubated=1)
Headache (%)	77
Nausea/vomiting (%)	53
Dizziness (%)	49
Fatigue (%)	37
Confusion (%)	35
Syncope (%)	14
Evaluation Symptoms (%):	
Attention and Concentration	91
Dizziness	63
Balance Problems	81
Headache	93
Vision Symptoms	65
Onset of symptoms: (<6 months post exposure)(n=37)	79
Neuro-Optometry Findings (%):	
Visual Pathology (Convergence/Divergence Disorders, Visual Field Defects, Dry Eye, Ocularmotor Defects, Accommodative Dysfunction)	91
Convergence Insufficiency	65
Peripheral Vision Defects	21
Ocularmotor Defect	33
Visual Evoked Potential abnormality (n=11)	73

The convergence insufficiency and peripheral vision defect findings are greater than what would be expected in the normal population. The prevalence for convergence insufficiency in a healthy population is 1 to 5%. Peripheral visual field defects in the elderly are less than 5%. The ocular motor defects and visual evoked potential changes are pathologic when compared to the appropriate accepted standards.

Summary/Conclusions: These finding support that CO poisoning can result in visual pathology. Of clinical importance, these may be responsive to rehabilitative interventions. Specialized visual evaluation and testing is an integral aspect of care in CO-poisoned patients with visual complaints or exam findings.

C 37

ORAL PRESENTATION TIME: 1036 - 1048
POSTER PRESENTATION TIME: 0900 - 0930
RESIDENT COMPETITION: YES

CARBON MONOXIDE POISONING MAY PRODUCE LONG TERM ELECTROENCEPHALOGRAPHIC ABNORMALITIES CONSISTENT WITH PERMANENT CEREBRAL NETWORK DYSFUNCTION

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Introduction: CO poisoning often results in permanent neurological sequelae. Literature about EEG abnormalities after CO poisoning is limited, and most relate to severe acute exposures rather than those with chronic ongoing complaints.

Materials and Methods: We queried our CO patient database to identify patients with EEGs following CO poisoning. We excluded patients with previous head trauma, neurologic disease, history of drug abuse or confounding medications. EEG abnormalities are present in 1% of patients with similar exclusions.

Results:

Patients with EEGs and Persistent Neurologic Symptoms, N=73	
Abnormal EEG, N=23*	**Normal EEG, N=50§**
Met Inclusion Criteria, N=12	**Met Inclusion Criteria, N=36**
Age, Y (Mean/Median/Range): 34/32/17-63 M/F: 3/9 HbCO%: (Mean/Median/Range) 20/18/7-32	Age, Y (Mean/Median/Range): 38/36/7-76 M/F: 20/16 HbCO%: (Mean/Median/Range) 17/16/3-39

*Exclusions: Medication (N=9), Epilepsy/epileptiform EEG (N=1), Trauma (N=1).
§Exclusions: Medication (N=12), Epilepsy (N=1), Trauma (N=1)

Twelve (30%) of 36 patients with persistent symptoms have abnormal EEGs greater than 1 year after exposure (mean 2.01, median 1.05). The disproportion of females with abnormal EEGs approaches significance ($p= 0.067$).

Specific EEG findings include diffuse generalized slowing (8), 2 with slowing in the theta range (4-7Hz), 2 in the delta range (1-3 Hz), and 1with mixed delta and theta slowing. Focal abnormalities were present in 7 patients (58%), predominantly left-sided temporal (3), hemispheric (2), fronto-temporal (1), posterior (1) and right hemispheric (1). Bilateral involvement was seen in the posterior (2) and frontal (1) tracings.

All 12 patients with abnormal EEGs described chronic headaches, memory, and balance disturbances since their poisoning. Other complaints included anxiety (6), vision changes (4), depression (4), and irritability (3).

Conclusions: Nearly one-third of patients we evaluated who had persistent symptoms have abnormal EEGs > 1 year after CO poisoning. Carbon monoxide poisoning may cause longstanding focal and/or generalized EEG abnormalities consistent with focal or generalized cerebral network dysfunction and neuronal loss.

C 38

ORAL PRESENTATION TIME: 1048 - 1100
POSTER PRESENTATION TIME: 0900 - 0930
RESIDENT COMPETITION: NO

EPIDEMIOLOGY OF ACCIDENTAL CARBON MONOXIDE POISONING FROM PORTABLE ELECTRICAL GENERATORS: A NATIONWIDE SERIES OF 264 CASES

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Background: Specific sources of carbon monoxide (CO) poisoning remain common in the US, with over 800 accidental deaths due to exposure to portable, gasoline-powered, electrical generator exhaust from 1999 to 2012. Because most data collected and reported in this area are mortality figures, description of the group referred for hyperbaric oxygen therapy nationally was performed to further define the population at risk.

Methods: Unidentifiable information about patients treated across the US with hyperbaric oxygen for acute CO poisoning was prospectively reported by participating centers online to a central data repository in real time fashion. Those patients poisoned by portable generators were selected for analysis.

Results: Of 1,604 patients treated with hyperbaric oxygen for accidental CO poisoning nationally from 8/1/2008 to 7/31/2011, portable generators were the source of CO for 264. Exposures occurred in 146 incidents in 33 states. Activity at the time of poisoning was classified as domestic in 101 incidents and occurred in a residence in 99 of those. Male (55%) patients' average age was 38 +/- 20 years (range 1 to 85 years) and female (45%) was 36 +/- 20 years (range 4 to 90 years). Race/ethnicity was 146 (55%) non-Hispanic White, 57 (22%) Black, 52 (20%), and Hispanic White, 4 (2%). English was spoken by 96%. The most common symptoms included headache (62%), dizziness (52%), and loss of consciousness (50%). Endotracheal intubation was performed in 18 patients. Blood carboxyhemoglobin levels averaged 22.7 +/- 9.0% (range 2.3 to 48.3%). Thirty-six patients demonstrated evidence of cardiac ischemia.

Conclusions: Acute, severe CO poisoning from portable electric generators is common in the US, occurring predominantly in residential settings and affecting English language speaking individuals. Using some assumptions, it is possible to extrapolate that about 4,000 persons are poisoned by generators annually.

C 39

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 0900 - 0930
RESIDENT COMPETITION: NO

AMBIENT CARBON MONOXIDE LEVELS MEASURED DURING 13 DAYS OF TRAVEL IN VIETNAM AND 13 DAYS IN THE UNITED STATES

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Background: China's air pollution problems are well publicized. It might seem that other countries in Asia should not have similar problems because they are largely agrarian, with lower population density and less industrialization. However, a recent report placed Vietnam 123rd of 132 countries in terms of air quality. Travelers on major routes in Hanoi are exposed to significantly elevated levels of both particulate matter and carbon monoxide (CO). Exposures are greatest during rush hour and while riding motorbikes, the country's primary mode of transportation

Objectives: The present study was conducted to determine levels of personal exposure to CO in both urban and rural areas of Vietnam. If, as has been suspected, motorbikes are the major source of air pollution, elevated CO levels should be found wherever they are in common use.
Methods: Ambient CO levels were measured and recorded every 10 minutes during 13 days of travel in Vietnam. A parallel study was performed in the US for comparison.

Results: Ambient CO levels in Vietnam ranged from 0-63 PPM, averaging 3.5 + 4.4 PPM (mean + SD). Ambient CO levels in the US ranged from 0-10 PPM, averaging 0.9 + 0.8 PPM ($p < 0.001$ vs. Vietnam average; unpaired two-way t test). In Vietnam, a total of 36 CO measurements (2% of total) were 15 PPM or greater , with 92% occurring adjacent to or within heavy traffic, always dense with motorbikes. No measurements were 15 PPM or greater in the US.

Conclusions: It is probable that CO exposures for commuters in Vietnam, as well as for those living alongside the routes, regularly exceed World Health Organization guidelines. Developing, primarily agrarian third world countries may have problems with air pollution even before large-scale industrialization. This should be addressed before economic growth leads to more severe problems.

C 40

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 0900 - 0930
RESIDENT COMPETITION: YES

MORBIDITY & MORTALITY IN NECROTIZING SOFT TISSUE INFECTIONS (NSTIS): HYPERBARIC OXYGEN VERSUS STANDARD THERAPY IN TWO URBAN HOSPITALS

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Necrotizing soft tissue infections (NSTIs) encompass three primary diagnoses: Necrotizing Fasciitis, Fournier's Gangrene and Gas Gangrene. These soft tissue infections have previously been considered separately, but due to the similarity of underlying pathogens, treatment, and associated illness severity, they have more recently been studied together. NSTIs are rare and life-threatening, with mortality as high as 73%, but with an average reported mortality of 25-39%. Given the rapidity of tissue destruction as well as the frequent sepsis and multisystem organ failure, NSTIs morbidity and mortality is very time sensitive to interventions. Standard therapy has consisted of surgery, antibiotics, and intensive peri-operative care. However, over the last 30 years there has been increasing use of adjunctive hyperbaric oxygen therapy (HBOT) to improve mortality and morbidity outcomes in NSTI. This will be a two-center, retrospective, case-control study of NSTI patients presenting to Regions Hospital and Hennepin County Medical Center over the last 10 years. Both Regions and HCMC are level one trauma centers with burn units, and HCMC has the capacity to treat patients with HBOT. We are comparing patients with NSTI who receive standard therapy and HBOT to those who receive standard therapy alone to determine (1) if those patients have a lower odds of inpatient mortality and (2) if those patients differ from patients who receive standard therapy alone in (a) the number of debridements received, (b) the length of time spent in the ICU, and (c) their overall length of inpatient stay.

C 41

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 0900 - 0930
RESIDENT COMPETITION: NO

HYPERBARIC OXYGEN THERAPY FOR COMPARTMENT SYNDROME

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A compartment syndrome is a serious condition that occurs after an injury, when there is insufficient blood supply to the muscles and nerves, due to increased intracompartmental pressure, it can result in necrosis of the muscles. When it is treated with the wrong primary care, it can lead to permanent muscle damage. The diagnosis can be difficult, and it should be considered for all patients with an extremity injury. The immediate effect of hyperbaric oxygen (HBO) is hyperoxygenation. Hyperoxia increases the delivery of oxygen to ischemic tissues, induces vasoconstriction, acts against infection, and has an important factor in wound healing, HBO is an effective intervention that counteracts the pathophysiological events which occur with these conditions.

We examined the treatment outcome of 49 compartment syndrome cases which were treated with HBO therapy in our hospital between 1989 and 2014. Many cases associated with trauma such as fractures, bruises and crush injuries. In the initial observation we note, that the symptoms of all were swelling and pain, especially with the passive stretch of the injured muscle of the diseased limb. Fifteen cases had a little paresthesia, but none had pulselessness and paralysis of the diseased limb. Decompressive fasciotomy had already been peformed in 5 cases and the others received conservative treatment with HBO within almost 24 hours after the initial evaluation. In only one case, we peformed a hematoma removal due to severe swelling five days after hospitalization. We were able to keep the diseased limb without major complication in all cases.

Generally, it is common to have prompt fasciotomy for compartment syndrome. However, we achieved good results by treating with HBO therapy as soon as it was clinically diagnosed, when the swollen limb was noticed and pain from the passive stretch of the involved muscle, was suspected.

C 42

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 0900 - 0930
RESIDENT COMPETITION: NO

HBO TREATMENT OUTCOMES FROM PATIENTS WITH BRAIN RADIONECROSIS FOLLOWING STEREOTATIC RADIOSURGERY

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Introduction/Background: Hyper baric Oxygen Treatm ent (HBOT) is used commonly for treating soft tissue radionecrosis , the treatm ent of central ner vous system radiation injury remains controversial. We report our experience treating patients with radionecrosis following successful stereotactic radiosurgery (SRS) for arterial venous malformations (AVM).

Materials and Methods: Four patients with radionecrosis after SRS were referred to our center. Neurologic symptoms began 3 to 47 m onths after SRS and continued to worsen despite medical management. All 4 patients had MRI evidence of edema in the area of the AVM prior to HBOT. Patients received MRIs as part of usual medical care. MRI improvement was determined from the MRI report. C linical improvement was assessed from referring physician's notes. One subject completed a 9-hole peg te st and trail-m aking test before treatm ent and at end of treatments.

Results:

Subject	Gender	Age	Dose (Gy)	#HBOT	ATA	Symptoms	MRI	Clinical status	9-hole peg	Trail making test
1	F	47	18.0	30	2.0	A, S	I	I	ND	ND
2	M	56	15.0	26	2.0	W, S	I	I	ND	ND
3	F	54	20.4	33	2.4	HA, V	I	NI	ND	ND
4	M	70	18.8 x2	40	2.4	W, V	I	NI	I	I

HA=Headache, W=Weakness, V=Visual Problems, A=Aphasia, S=Seizure
I=Improved, NI=Not improved, ND=Not Done

The MRIs of all 4 patients im proved after HBOTs. Clinical neurologic sym ptoms improved for 2 patients. One patient denied sym ptomatic improvement, but had significantly im proved performance on the 9 hole peg and trailing m aking tests. Sym ptoms didn't worsen in the remaining patient who reported no symptomatic improvement.

Summary/Conclusions: MRIs improved in all patients after HBOT. Symptom progression halted in all patients and 2 had symptom atic improvement. This series supports others showing improvement in brain radionecrosis with HBOT. Consistent standards for measurement and entry of all hyperbaric patient data into a registry would allow data comparison from multiple centers.

C 43

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 0900 - 0930
RESIDENT COMPETITION: YES

HYPERBARIC OXYGEN THERAPY FOR PREVENTION OF SICKLE CELL VASO-OCCLUSIVE EPISODES

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Introduction/Background: Sickle Cell Disease (SCD) is a common inherited condition which causes abnormal hemoglobin to polymerize under hypoxic conditions. The sickled red blood cells are unable to deform in the microvasculature which leads to vaso-occlusive episodes (VOE) characterized by ischemia, intense pain, and necrosis of tissue. The standard treatment for a VOE requires intravenous fluids, narcotics, and potentially admission and other supportive care. Patients undergoing hyperbaric oxygen therapy (HBO) have a significant increase in the PaO2 of the blood and tissues. We report on the use of HBO for a patient with SCD who had a reduction in the number of hospital admissions for VOE while undergoing HBO.

Materials and Methods: A 22 year-old female with severe SCD was treated with HBO for preparation of graft/compromised graft for a chronic non-healing sickle cell ulcer. HBO was initiated while she was admitted for a VOE. The patient was treated at 2.0 ATA for 90 minutes for a total of 50 treatments over 3 months.

Results: The patient was hospitalized 17 times in 24 months (0.71 admissions per month) for VOE prior to HBO with an average length of stay of 11.4 days. The patient had 1 VOE in 3 months (0.33 admissions per month) while undergoing HBO which occurred after treatment 22 requiring a 12 day stay in the hospital.

Summary/Conclusions: HBO has not been previously reported as a modality for preventing sickle cell crisis. HBO reduced this patient's incidence of sickle crisis from 0.7 admissions per month to 0.3 admissions per month. The dramatic reduction may indicate a role for HBO in the prevention of sickle cell crisis.

C 44

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 0900 - 0930
RESIDENT COMPETITION: YES

HYPERBARIC OXYGEN FOR AVASCULAR NECROSIS OF THE FEMORAL HEAD: A CASE STUDY

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Introduction: We report a case of HBO used to treat avascular necrosis of the femoral head. Significant pain reduction was found at the end of therapy.

Materials and Methods: A 47 year old male was initially admitted to an outside hospital for perforated diverticulitis. Colectomy and Hartman pouch was performed, which unfortunately led to the development of pelvic abscesses and pelvic osteomyelitis. Surgical debridement and drainage was required and after a long course of intravenous antibiotics the patient's infection cleared. However, our patient continued to complain of left hip pain. He was diagnosed with aseptic avascular necrosis (AVN) of the hip. He underwent 40 HBO treatments at 2.5 ATA for 90 minutes.

Results: Significant pain reduction was found at the end of 40 HBO treatments. At subsequent patient follow-up he reported a reduction in pain from 8/10 to 0/10 pain with increased range of motion of his hip. His opiate requirements were greatly reduced, and he reported that he was being weaned from them. The patient's activities of daily living improved enough to allow for physical therapy. He reported an increase in his social activity as a result including multiple weekly trips out of the house with family to places such as the mall.

Summary: HBO for avascular necrosis of the femoral head has not been a well established treatment modality. However, we present a case of successful pain reduction and opioid requirements from a patient with AVN of the femoral head after 40 treatments. This resulted in an improved quality of life for the patient. HBO may be of benefit for AVN and warrants further study.

C 45

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 0900 - 0930
RESIDENT COMPETITION: YES

HYPERBARIC OXYGEN TREATMENT FOR POST-RADIATION CENTRAL NERVOUS SYSTEM INJURY: A RETROSPECTIVE CASE SERIES

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Introduction/Background: Increased use of radiation therapy and increasing life spans following radiation treatment has led to an increase in the finding of post-radiation central nervous system injury in patients who have previously undergone radiation treatments. At this time, information regarding treatment for patients suffering from this serious side effect is limited and not readily available. It is imperative to examine possible treatment options, complications and success rates for these patients.

Materials and Methods: This retrospective review will look at 10 patients who underwent hyperbaric oxygen therapy for post-radiation injury to the central nervous system. Review and investigation of the subjective, clinical and radiologic outcomes of these patients was conducted.

Results: It was determined that for patients with post-radiation central nervous system injury it is important to distinguish the exact diagnosis for each patient. For those patients with radiation necrosis, conclusion was made that hyperbaric oxygen (HBO2) therapy does lead to improvement in subjective, clinical and radiologic outcomes. However, the results were not consistent across all patients. For those patients with non-specific delayed radiation injury, findings showed that HBO2 does not lead to any improvement.

Summary/Conclusions: Therefore, we conclude that for those patients who have been diagnosed with radiation necrosis of the central nervous system, we recommend HBO2 therapy as a potential treatment option for some patients.

C 46

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 0900 - 0930
RESIDENT COMPETITION: YES

COMPROMISED BREAST FLAP TREATED WITH LEECH THERAPY, HYPERBARIC OXYGEN, TOPICAL NITROGLYCERIN AND PENTOXIFYLLINE

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Introduction/Background: Compromised flaps are complications where Hyperbaric Oxygen (HBO2) is often indicated. Although limited to animal models, the utilization of leech therapy (Hirudo medicinalis) and concomitant HBO2 has shown superior outcomes (Lozano DD, Plastic & Rec Surg, 1999). We present a case of successful breast flap salvage utilizing a combination of leech therapy, HBO2, topical nitroglycerin and pentoxifylline.

Materials/Methods: A 34-year-old female, one day post-status breast reduction surgery developed left nipple dusky discoloration and venous congestion, indicating imminent flap failure. Her surgeon ordered the placement of topical nitroglycerin, oral pentoxifylline, and referred her for HBO2. After her first HBO2 treatment, there was improvement to the superior portion of the areolar flap, with little improvement on the inferior portion where the venous congestion had remained unchanged. To address this, we decided to add leech therapy and the topical nitroglycerin was discontinued.

Ceftriaxone for Aeromonas prophylaxis was started and leeches were attached 2 at a time, and removed from the area once feeding had ceased. These were applied three times per day for 3 days while receiving HBO2 twice per day for 6 days.

Results: The case presented was a successful salvage of a breast flap that healed by 8 weeks without requiring further surgical intervention.

Conclusions: We present a case of successful healing of an ischemic breast surgical flap using HBO2, pentoxyfylline, topical nitroglycerin and leeches. This is the first case published to our knowledge of a salvaged compromised breast flap in this manner.

C 47

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 0900 - 0930
RESIDENT COMPETITION: NO

HBOT FOR DELAYED-RADIATION INJURY SECONDARY TO FLUOROSCOPY IN PATIENT WITH A NON-HEALING BACK WOUND

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Introduction/ Background: Radiation injuries can cause acute, sub-acute or, in this case, delayed complications. Delayed radiation complications become apparent after six months but may present themselves years after radiation exposure. Current evidence demonstrates how peak skin radiation dose amounts and time after irradiation can affect these patients' skin. However, patients' responses to irradiation can be variable. Nevertheless, it is scientifically known that hyperbaric oxygen therapy (HBOT) stimulates angiogenesis and causes neovascularization in poorly oxygenated tissues. Because of this, delayed radiation injury patients are treated successfully with HBOT.

Materials and Methods: The following case study involves a 53 years old male patient with a non-healing back wound following embolizations and radiation that he received during fluoroscopy. Clinical information is examined and wound photos substantiate the patient's outcome.

Results: The patient received wound care and 60 HBOT treatments at 2 ATA for 90 minutes followed by flap and graft surgeries. The wound is now healed.

Summary/Conclusion: In 2005, this case study patient underwent multiple embolizations for spinal arteriovenous malformations under fluoroscopy. As delayed-radiation injury is not usually common in patients who undergo fluoroscopy procedures, the cause of these developing wounds was not considered initially by health care providers. The patient estimated that he underwent 12-14 total hours of fluoroscopy. In addition, the patient has a nerve stimulator implanted in his back that altered the patient's HBOT treatment protocol. The patient's lifestyle, extensive medical and surgical history, wound care interventions, HBOT treatments, and health care insurance issues also contribute to this patient's outcome. This exploratory case study suggests that there may be other such patients who can benefit from HBOT.

C 48

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 0900 - 0930
RESIDENT COMPETITION: NO

HYPERBARIC OXYGEN TREATMENTS FOR IMPROVING STUMP SALVAGE AFTER ABOVE THE KNEE AMPUTATION IN PATIENTS WITH SEVERE UNRECONSTRUCTABLE VASCULAR DISEASE

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Introduction/Background: Patients with severe unreconstructable vascular disease (with or without diabetes) requiring amputation, often have postoperative wound complications, sometimes due to continued hypoxia. These complications can prolong hospital stays and lead to further surgery. Hyperbaric oxygen may help to relieve hypoxia, improve wound healing, and prevent re-operation.

Materials and Methods: Four patients with above the knee amputations due to severe unreconstructable vascular disease developed non-healing, necrotic wounds at the amputation site and were referred to our hyperbaric center. All 4 patients were at risk for major stump revision. Three patients had continued hypoxia at the wound site as evidenced by skin mottling and continued tissue necrosis. Two of the patients also had significant groin wounds. Hyperbaric Oxygen Treatments (HBOT) were added to the standard care of VAC dressings, wound debridement, and nutritional supplementation.

Patient	1	2	3	4
Age	54	60	65	63
Diabetic	No	Yes	No	No
Smoking	Active	Active	Former	Active
Wound hypoxic	Yes	Yes	Yes	No (infected)
Pre albumin @ start of HBOT	15	14	10	13
Treatment ATA	2.4	2.0	2.0	2.0
# of HBOTs	29	39	27	23
# of debridements after HBOT started	4	5	2	0
Days from surgery to start of HBOT	11	60	20	31

Results: All 4 patients went on to completely heal their stumps without major revision and were fitted successfully with prostheses. The groin wounds also healed.

Summary/Conclusions: HBOT helps heal complex wounds after above the knee amputations and can avert further surgery, particularly in cases with persistent hypoxia.

C 49

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 0900 - 0930
RESIDENT COMPETITION: NO

HYPERBARIC OXYGEN THERAPY MATTERS FOR DIABETIC FOOT ULCERS

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Introduction: Adjunctive hyperbaric oxygen therapy (HBOT) is approved for diabetic foot ulcers (DFU) that have not improved despite standard wound treatment. Recently there have been conflicting reports about the efficacy of HBOT for DFU. The purpose of this study is to evaluate the effects of HBOT on reducing wound size for DFU patients treated at our facility.

Methods: A retrospective review of patient records from 2007 to 2012 was done for diabetic outpatients and inpatients treated with HBOT at Loma Linda University Medical Center. Records of demographic data, indications for HBOT, and wound measurements before and after the last HBOT were collected. Only diabetic patients with an ulcer in the foot area were included in this study. All subjects received standard wound care at the wound clinic while undergoing HBOT.

Results: Fifty-seven DFU patients were treated with HBOT. Twenty-one patients' records contained acceptable data for this study. Patients ranged in age from 20 to 87 years with 12 males and 9 females. All HBOT treatments were performed at 2.0 ATA for 90 minutes 5 days a week for a total of 20 to 60 treatments. Two patients had less than 10 treatments and were excluded from the final wound evaluation. Fourteen (74%) subjects experienced a decrease in wound size ($p=0.062$), with 12 (63%) having more than 50% reduction during the evaluation period ($p=0.91$). Five (26%) had an increase in wound size ($p=0.171$). Upon one month follow-up visit post HBOT completion, 3 subjects had complete healing. There were no adverse effects from HBOT. Of the evaluable subjects none required amputation.

Conclusion: In our preliminary results, we found a trend toward significant reduction in wound size after a course of HBOT. A more comprehensive study is underway to evaluate any beneficial effects of HBOT as an adjunctive therapy for DFU patients.

C 50

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 0900 - 0930
RESIDENT COMPETITION: YES

RETROSPECTIVE CASE SERIES OF PATIENTS WITH RADIATION INDUCED OPTIC NEUROPATHY TREATED WITH HYPERBARIC OXYGEN

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Introduction/Background: Radiation induced optic neuropathy (RION) is a rare but devastating complication of radiation treatment for cranial neoplasms, which typically develops months to years after treatment and often leads to blindness. Very little literature exists that demonstrates the efficacy of hyperbaric oxygen therapy in the treatment of RION. The purpose of this study was to evaluate our institutional experience in managing RION through a retrospective review of cases from a large urban academic center.

Materials/Methods: A retrospective chart review was conducted to include all RION cases from 2007 to 2013 that were treated at the Division of Undersea and Hyperbaric Medicine. Vision was assessed in the chart review objectively through visual acuity and subjectively by patient comments.

Results: 9 total cases of presumptive RION were documented. 2 patients had treatments stopped because vision loss was found to be caused by new tumor growth. 2 patients demonstrated vision improvement, 1 patient had vision stabilization, and 4 patients had worsening of their vision.

Summary/Conclusions: Stabilization or improvement of vision occurred in 3/7 patients treated with hyperbaric oxygen therapy for RION. Due to the paucity of available treatments for RION and severe outcome of blindness, treatment for RION with hyperbaric oxygen therapy is not unreasonable.

C 51

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 0900 - 0930
RESIDENT COMPETITION: NO

INTRODUCING DIABETES-ASSOCIATED LIMB DISEASE (DAL-D) AS A NEW CLASSIFICATION FOR DIABETIC LOWER EXTREMITY WOUNDS

Yang BW, Levine J, Chacko B, Maurais S, Friedman H, Hurst S, Singh B, Ouseph J, Kurunathapillai K, Saeed M, Selvaraj S, Goumas W, Liberis G, Rosas D, Hurst S, Qurashi S
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Background: If surgical wounds fail to close after minor amputations of diabetic foot ulcers (DFU) and result in non-healing wounds, do patients still have diabetic foot ulcers? Because the Wagner DFU classification fails to include non-healing surgical wounds, many post-operative cases are excluded from the DFU category. To better reflect diabetic limb salvage as a continuum of the different phases described below, we devised a new system of classifying diabetes-associated limb disease, called DAL-D.

DAL-D's three phases are:

(i) Hyper-acute DAL-D, which includes necrotizing fasciitis and gas gangrene, both of which require immediate intervention;
(ii) Acute DAL-D, which includes conventional Wagner grade wounds that remain unhealed for up to 30 days, and post-operative wounds (such as flap failure, wound dehiscence, or non-healing wounds) that remain unhealed for up to 30 days from the date of the operation; and
(iii) Chronic DAL-D, which are unhealed acute wounds that remain unhealed for more than 30 days.

Material and Method: To exam the applicability of the DAL-D system, we reviewed all diabetic lower extremity wound cases treated at the Good Samaritan Hospital hyperbaric medicine department in 2013 that we re-categorized under the DAL-D system.

Result: A total of 20 patients in 25 separate accounts were treated for DAL-D in 2013. Hyper-acute DAL-D (16% of total, n=4) were all necrotizing fasciitis. Acute DAL-D (44% of total, n=11) included 8 flap failures, 2 secondary-intention wound closures and 1 delayed flap failure. Chronic DAL-D (40% of total, n=10) included 4 Wagner grade 3 DFUs, 2 Wagner 4 DFUs, 2 delayed flap failures, 1 post-operative flap failure and 1 chronic osteomyelitis.

Conclusion: The DAL-D classification more accurately reflects modern diabetic limb salvage protocols because it includes not only conventional diabetic foot ulcers (as in the Wagner classification), but also all pre-operative and post-operative surgical cases.

C 52

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 0900 - 0930
RESIDENT COMPETITION: NO

FROSTBITE INJURY TREATED WITH HYPERBARIC OXYGEN THERAPY

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Introduction/Background: Frostbite injury develops after exposure to temperatures below -2C. Tissue injury is superficial, without underlying tissue loss, or deep, with significant tissue loss. Cold exposure causes vasoconstriction, tissue ischemia, then vasodilation. Blood plasma ice formation increases blood viscosity. Microvascular thrombi form. Microvascular damage ensues causing tissue ischemia, triggering inflammatory responses and endothelial damage leading to increased vascular permeability and edema. Intracellular ice formation promotes cell membrane rupture. Extracellular ice raises oncotic pressure causing fluid shifts, cellular dehydration and disruption of intracellular metabolism. Additional tissue damage develops from re-perfusion injury.

Methods: This man was exposed to an ambient temperature of -27C for 10+ hours. On presentation his core temperature was 31.9C. He had frostbite injury of his bilateral fingers, knees, and toes. He was treated emergently with core rewarming, tPA 200 mg infusion over 2 days, followed by heparin infusion for 6 days, and hyperbaric oxygen therapy (HBOT) initiated 31 hours after the patient was found; (5 sessions; twice daily at 2.4 ATA,, then 4 daily sessions at 2.0 ATA).

Results: His bone scan improved after 3 HBOT sessions. His tissue loss was limited to his bilateral fingers 2 – 5 and his anterior knees. His thumbs and toes were spared.

Summary/Conclusions: HBOT reduces cold induced tissue damage by hyper-oxygenating ischemic tissue, reducing tissue reperfusion injury, promoting angiogenesis and optimizing leukocyte function. The goal is to preserve at risk ischemic tissue.

C 53

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 0900 - 0930
RESIDENT COMPETITION: NO

THE EFFECTIVENESS OF HYPERBARIC OXYGEN THERAPY (HBOT) IN TREATING POST-SURGICAL DIABETIC FOOT WOUNDS

Yang BW, Levine J, Chacko B, Maurais S, Singh B, Ouseph J, Kurunathapillai K, Saeed M, Selvaraj S, Goumas W, Liberis G, Rosas D, Hurst S, Friedman HE, Hurst S, Qurashi S
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Introduction: Because of neuropathy and ischemia, diabetic foot surgery results in a high rate of surgical complications such as failure of flap, wound dehiscence and delayed or non-healing wounds. At Good Samaritan Hospital, we used HBOT to treat complicated surgical wounds with high success.

Material and Method: We reviewed all diabetes-related leg wound cases treated at the Good Samaritan Hospital hyperbaric medicine department in 2013.

Result: A total of 20 patients in 25 separate accounts of diabetes-related leg wounds were treated in 2013. 56% (n=14) of total cases were the following post-operative wounds: (i) compromised flaps, (ii) necrosis of previously closed flaps (delayed flap failure), and (iii) delayed healing wounds with secondary intention wound closure.

50% of cases involved toe amputation, 21% mid-foot amputation, 21% debridement of deep tissue, and 7% sesamoid bone resection.

All patients had diabetic neuropathy. 79% (n=11) of patients had peripheral arterial disease. 71% (n=10) of patients received revascularization procedure (bypass n=3, angioplasty n=7).

78% (n=7) of compromised flaps (n=9) healed completely after 20±17 HBOT sessions.

33% (n=1) of delayed flap failures (n=3) healed. The single case that healed received 79 sessions of HBOT, whereas the two non-healing cases were prematurely discontinued and received only 7 sessions and 1 session, respectively.

100% (n=2) of secondary intention wound closure (n=2) cases healed completely after 58 and 59 sessions of HBOT, respectively.

Conclusion: HBOT appears to be a highly effective treatment for complicated surgical wounds after diabetic foot surgery.

C 54

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 0900 - 0930
RESIDENT COMPETITION: NO

IATROGENIC CEREBRAL GAS EMBOLISM SUCCESSFULLY TREATED WITH HYPERBARIC OXYGEN THERAPY

Gwilliam AM, Stewart JR, Robins MS
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Introduction/Background: "HBO2 to treat gas embolism remains the definitive treatment for gas embolism. Indications for treatment include neurological manifestations or cardiovascular instability."

Materials/Methods: A 35 YO female with anorexia/bulimia presented to the ED for rehydration therapy of NS through her port-a-cath. Co-morbidities: ESRF, hypokalemia, dehydration and OCD/depression.

During IVF therapy, administered with a pressure bag, the patient became unresponsive needing a full code to resuscitate. She was transferred to the ICU. CT of head showed "… gas within the cavernous sinus, superior sagittal sinus as well as multiple cortical veins over the frontal and parietal lobes on the right. Extensive gas within cervicocerebral venous structures. Intracranially, gas is present primarily a cortical venous distribution of the right frontal and parietal lobes with other smaller foci of gas… A massive intravenous injection of gas could result in this appearance."

Literature reports show decreased time between the insult and HBO2 is associated with better outcome. HBOT was initiated within 120 minutes of onset. Pre-treatment examination showed the patient able to answer simple questions but unable to follow commands; left side hemiparesis, poor eye tracking, and a contracture fist were found.

Navy dive Table 6 was administered: 3.0 ATA for 75 minutes then 265 minutes at 2.0 ATA on 100% oxygen with air breaks.

Results: Twenty four hours later repeat CT showed "The previously defined intracranial gas…has cleared… Clearance of the scalp and soft tissue gas previously defined."

The patient received additional HBOT 12 hours later then refused further treatment d/t claustrophobia. At discharge from the hospital the patient had full movement with no evidence of residual effects of the event.

Summary/Conclusions: Though this mishap could have been fatal, it was averted by quick administration of HBOT. The patient now has full use of all extremities with no long term sequelae.

C 55

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 0900 - 0930
RESIDENT COMPETITION: NO

BENEFITS OF EPIDERMAL HARVESTING FOR WOUND CLOSURE

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The wound healing phase of epithelialization can last weeks to months. A split-thickness skin graft (STSG) is another closure option. However, it has several negative consequences: a second, often painful donor site wound[1], increased risk of infection[2] and scarring to both donor and grafted site[3]. Case studies highlight an in-office procedure, epidermal harvesting (EH), which speeds healing and is less invasive (no surgery cost or risks). Donor site wound is minimal, healing quickly.

#1: 16 y.o. male sustained metatarsal fractures while rock climbing leading to fracture blisters on dorsal foot. Blisters were debrided exposing muscle and tendon. After months of wound care (NPWT, matrix, HBOT), granulation tissue filled the defect with tendon still exposed. Surgeon refused STSG with exposed tendon. The patient had severe pain and the donor site could add more. EH was performed with minimal pain. Although the site harvested was smaller than the wound, cells migrated to cover the entire defect within weeks.

#2: While hiking, 23 y.o. woman had a boulder fall, crushing her foot. Surgeons tried desperately to save the foot but some toes were lost. The defect was slow to heal, frustrating this very active patient. The decision was made to use EH instead of STSG. Epithelial covered within 3 weeks. Donor site healed within a week.

#3: 56 y.o. diabetic woman with slow healing post-surgery foot wound. After months of wound care, granulation was complete, without epithelialization. The patient refused STSG, not wanting another large non-healing wound; she chose EH. Both areas healed completely.

EH uses negative pressure and heat to harvest the epidermis into "microdomes" full of growth factors. These epidermal cells are transferred to the wound as an autologous graft. This procedure, performed in less than an hour, can decrease pain and trauma, and shorten healing time for appropriately chosen patients.

C 56

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 0900 - 0930
RESIDENT COMPETITION: NO

HYPERBARIC OXYGEN AS ADJUNCT FOR COMPLEX REGIONAL PAIN SYNDROME: CASE REPORT

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Introduction: Complex regional pain syndrome (CRPS) is a chronic, debilitating disorder characterized by intense, burning (vasomotor) pain, allodynic response to touch, edema, hyperhydrosis and changes in skin color and temperature. Early diagnosis and treatment offers the best outcome, however many cases remain refractory to standard treatment modalities. Hyperbaric oxygen (HBO) therapy may offer an additional treatment option. Promising results have been seen in earlier case reports and one double-blind randomized placebo-controlled study.

Methods: The case of a 47-year-old male is presented with Stage III CRPS which began following a snowmobile accident in 2002. He suffered multiple injuries including frostbite requiring amputation of several right-sided digits, a right-sided brachial plexus avulsion at C5 and C6 roots, and a traumatic brain injury. He developed excruciating burning right arm pain immediately following the accident that has remained refractive to narcotic analgesics, stellate ganglion blocks and motor cortex stimulation for over 12 years. The arm was cold with blue, mottled skin and his daily pain has been 10/10 despite maximum dose pain medications. He was treated with 42 sessions of HBO therapy at 2.4 ATA over 8-weeks.

Results: By the end of treatment, the patient's right arm was pink, warm and uniform in color, his daily pain was 0/10, his narcotics for breakthrough pain had been discontinued, and his daily pain meds were slowly being withdrawn. He will be followed to determine if these results are lasting.

Conclusions: Inhibited sympathetic vasoconstriction and exaggerated neurogenic inflammation may be the main pathophysiologic mechanisms inducing the burning vasomotor pain of CRPS. HBO therapy reverses these effects by causing vasoconstriction, reducing tissue edema and hyper-oxygenating hypoxic tissues. Future studies should be considered to confirm efficacy in similar cases and, if successful, to determine the best point at which to initiate HBO therapy when treating CRPS.

C 57

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 0900 - 0930
RESIDENT COMPETITION: NO

HBO AS ADJUVANT THERAPY IN LESIONS SUBSEQUENT TO THE BITE OF AN ATROX ALBINUS RATTLESNAKE. A CASE REPORT IN HUMAN

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Introduction: During the usual care of the animals entrusted to him, the Director of the reptile house in the Republic of San Marino received a single-tooth bite to his left hand by one of the most venomous snakes present: an Atrox Albinus Rattlesnake. Reported effects of this envenomation are: skin lesions, hemolysis, rhabdomyolysis, toxic shock, disseminated intravascular coagulation.

Materials and Methods: The patient: Male, 61 y.o.; soon after the bite self-applied a tourniquet and moved on his own to the local ER, where he was found conscious, cooperative and hemodynamically stable. The left hand demonstrated numerous hemorrhagic vescicles and progressing edema. At the wrist and forearm serous-hemorrhagic flittenae were developping. There was sinificant swelling, extending up the shoulder. Posterior ecchymotic lesions were present at the root of the arm. There were no significant changes in motility nor sensorium of the left arm and hand; ulnar and radial pulses were palpable. The envrnomation was judged as severe, but there were no systemic signs of toxicity. The laboratory tests reveal a modest leukocytosis. Diuresis was preserved (at least 1ml/Kg/h). Over the next few hours the patient received intravenous supportive therapy and benzodiazepines for anxiety. Treatment: The patient received fluids and antibiotic prophylaxis (amoxicillin/clavulanic acid: 1.2gx3/die) and a standard initial dose of 6 vials of antidote. On the 3rd day after continuing conservative therapy the patients received surgical curettage with extensive dressing change and drainage of localized skin bullae; and initiated adjuvant Hyperbaric Oxygen therapy, repeated 6 times, at 2.4 ATA, 25'x3 at a FiO_2=1, two 5' (minutes) air-breaks interposed. HBO was initiated owing to an incipient compartment syndrome (1,2,3), and it was continued daily up to a safe discharge of the patient; he left the hospital after initiating rehabilitation therapy and with healing hand lesions.

Results: The cutaneous lesions were healed in 40 days. At 8 months there's persistent stiffness of the left hand, the patient reports progressive improvement but closure of the hand is still partial (extimated 60-70%).

Conclusions: In this case of rattlesnake-envenomation, HBO provided adjuvant therapy for the suspected ischemic areas of the hand and forearm. Previous descriptions of HBO after envenomations appear to be useful in the post-acute phase

References: 1. Stolpe MR et Al: Ann Emerg Med, 1989; 18(8): 871-4; 2. McGrath T et Al: Undersea Hyperb. Med, 2010 ;37: 393-4; 3. Rainer PP et Al: Undersea Hyperb. Med, 2010 ; 37: 395-8

C 58

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 0900 - 0930
RESIDENT COMPETITION: NO

HBO FOR SEVERE CARBON MONOXIDE POISONING IN AN ICU SETTING. A RETROSPECTIVE ANALYSIS

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Background: CO-poisoning cause serious illness and morbidity. We present data from a 5 year experience of treating patients with carbon monoxide poisoning with hyperbaric oxygen therapy (HBOT) at a major referral centre of Copenhagen, Denmark.

Methods: We did a retrospective analysis of a cohort of seriously CO poisoned patients who were unconscious due to CO and/or combined smoke inhalation injuries after exposure to fire and treated at our facility with HBOT. The cohort consisted of patients treated during a period from 01.01.2008 to 31.12.2012.

Results: During this 5 year period, 925 patients were hospitalized and registered with the exclusive diagnose of CO-poisoning on a national scale. Of these 925 patients, 51 patients were treated for severe CO poisoning requiring sedation and mechanical ventilation. Of the 51 patients, 50 patients were given HBOT using a protocol with a total of 5 sessions to 2.8 atm.abs. for 90 min (no airbreaks) given within the first 48 hours from admission. The numbers of ICU days were 214 with an overall ICU mortality of 3.9%. The 30 day mortality rate was 5.9% and the 90 day mortality were 7.8%. The SAPSII predicted mortality was 31.9%. The standardized mortality rate (SMR) at 30 days were 0.18. When including burn patients – a total of 77 - the ICU mortality were 13.0%, the 30 day mortality 18.2% and 90 day mortality 19.5% with an SMR of 0.54 at 30 days.

Summary: The fraction of HBO treated patients requiring intensive care with sedation, mechanical ventilation and HBO were 5.5% as compared to the total number of National hospital admissions. The SAPS II (31.9%) and 30 day predicted SMR (0.18) is higher than observed for patients with no burn injuries. Similarly for patients with burn injuries.

KINDWALL LECTURE: *Myth Busting in Carbon Monoide Poisoning*

Neil Hampson, MD, FUHM

1100 - 1200

Dr. Eric P. Kindwall *is known by so 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. He died Jan. 18 after a long illness. Dr. Kindwall has played a great role in growing and shaping the specialty of Undersea and Hyperbaric Medicine. He has likewise been 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 has 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. Some of us have been blessed to have had a closer impact by Dr. Kindwall's life, but I think that I can easily say that each of us has been influenced in some way.*

KINDWALL MEMORIAL LECTURE KEYNOTE SPEAKER

NEIL HAMPSON, MD, FUHM

Dr. Hampson is currently Physician Emeritus at the Center for Hyperbaric Medicine at Virginia Mason Medical Center and Clinical Professor of Medicine in the University of Washington, both in Seattle.

Dr. Hampson received his medical degree at the University of Washington. He completed an Internal Medicine residency at the University of Iowa, then a Pulmonary and Critical Care fellowship at Duke University. He spent one year as a faculty member in the Duke Department of Medicine, then moved to Virginia Mason in 1988. He served as Medical Director of the Center for Hyperbaric Medicine from 1989-2010. He is board-certified in Internal Medicine, Pulmonary Disease, Critical Care Medicine and Undersea and Hyperbaric Medicine.

He is Past-President of the Undersea and Hyperbaric Medical Society, former Chairman of the UHMS Hyperbaric Oxygen Therapy Committee, and former member of numerous UHMS committees and task forces. He is a member of the Examination Committee of the American Board of Preventive Medicine, Subcommittee for the Undersea and Hyperbaric Medicine Examination.

Dr. Hampson's comprehensive work on the epidemiology and prevention of carbon monoxide poisoning and treatment of chronic tissue radiation tissue injury with hyperbaric oxygen has been extensively recognized in the field of hyperbaric medicine. He has received the Winter Hyperbaric Medicine Symposium Award for Contributions to the Advancement of Hyperbaric Medicine, UHMS Paul Bert Award, UHMS Pacific Chapter Merrill P Spencer Lifetime Achievement Award, Boerema Award for Exceptional Contributions to the Field of Hyperbaric Medicine and the UHMS Ray Award.

He retired from clinical practice in 2010. He lives during the summer and fall on Camano Island, Washington where he catches Dungeness crab and farms oysters. He spends winters in Anthem, Arizona where he attends major league baseball spring training and enjoys the sunshine.

Myth Busting in Carbon Monoide Poisoning

This presentation will briefly review the areas of carbon monoxide (CO) poisoning research that Dr. Hampson has pursued over the course of his career. He has published over 50 peer-reviewed articles in the medical literature on the topic, more than any other individual. He is known for his skepticism of widely held "truths" and has demonstrated time after time that going back to find the original data often yields insufficient support for a concept, or none at all. He will discuss 9 topics in CO poisoning that were "common knowledge" when he entered the field in 1990 and which he has subsequently disproven. Topics to be included will be epidemiology, diagnosis, evaluation and treatment of CO poisoning. He will teach you to question what you hear, think outside the box, and go back to the original source for a manuscript citation, especially if he will be reviewing your paper.

SESSION D
Diving and Dive Accident Management

D 59

ORAL PRESENTATION TIME: 1330 - 1342
POSTER PRESENTATION TIME: 1530 - 1600
RESIDENT COMPETITION: YES

HYPEROXIC MYOPIA: A CASE SERIES OF FOUR DIVERS

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Introduction: Hyperoxic myopia is a phenomenon reported in individuals who have prolonged exposure to an increased partial pressure of oxygen (PO_2) and subsequently have a myopic (nearsighted) change in their vision. To date, there are numerous accounts of hyperoxic myopia in dry hyperbaric oxygen treatment patients; however, there have only been three confirmed cases reported in wet divers. This case series adds four confirmed cases of hyperoxic myopia in wet divers using 1.35 ATM PO_2 at the Navy Experimental Diving Unit (NEDU).

Materials and Methods: The four divers involved were the author's patients at NEDU. Two divers' conditions were confirmed via record review, whereas the other two stricken divers were diagnosed by the author. All subjects were interviewed to correlate subjective data with objective findings.

Results: All subjects had six hours of exposure to a PO_2 of 1.35 ATM for five consecutive days. Each individual was within the U. S. Navy Dive Manual's standards for general health. Prior to diving, visual acuity was measured. Within three to four days after diving, the individuals had complaints of blurry vision with a myopic refraction shift. Each diver had spontaneous resolution of his myopia over the next two to three weeks with no significant residual symptoms.

Conclusions: The divers in this case series were exposed to an increased PO_2 (1.35ATM for 30 hours in 5 days) a lesser exposure than that in other reports of hyperoxic myopia in wet divers diagnosed with hyperoxic myopia (1.3-1.6 ATM for 45-85 hours in 12-18 days). Furthermore, this pulse of exposure is more concentrated than typically seen with traditional hyperbaric oxygen therapy. Hyperoxic myopia continues to be a risk for those conducting intensive diving with a PO_2 between 1.3-1.6 ATM. Additional investigation is warranted to better define risk factors and PO_2 limits regarding ocular oxygen toxicity.

D 60

ORAL PRESENTATION TIME: 1342 - 1354
POSTER PRESENTATION TIME: 1530 - 1600
RESIDENT COMPETITION: NO

DIVERS ALERT NETWORK FATALITY DATABASE REVIEW FOR BREATHING GAS CONTAMINATION: 2004-2012

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Introduction/Background: Breathing gas contamination during diving is rare but suspected to be under-reported. Intoxication by contaminants such as carbon monoxide (CO), carbon dioxide (CO_2) volatile hydrocarbons, oil and particulates may disable divers and result in drowning. Symptom based confirmation of intoxication without gas analysis is difficult. The objective of this review was to establish how often gas analysis was included in scuba fatality investigations and how often gas contamination contributed to the death of divers.

Materials and Methods: We reviewed records in the Divers Alert Network (DAN) fatality database of US and Canadian citizens from 2004-2012 (n=761). Determination of gas analysis use, contamination and cause of death was made based on available gas analysis reports from accredited laboratories, autopsy findings, and investigative reports. Compressed Gas Association (CGA) G-7.1-2011 Grade E limits were used as the contaminant level standard.

Results: Breathing gas was analyzed post mortem in 120 (16%) cases (n=761). Findings were unknown or not available for 641 (84%) cases (n=761). We reviewed available gas analysis reports (n=120) and found 77 (64%) cases had no significant contaminants present. Nine (8%) cases reported significant levels of breathing gas contamination, of which in two we considered contamination as a contributing factor to cause of death. Contaminants detected included odor (n=3), and one case each of excess methane and hypoxic gas mix, humidity, CO, CO_2, oil and particulates and one unidentified.

Conclusions: Gas analysis is infrequently included in scuba fatality investigations and rarely implies causal gas contamination. Analysis findings may reveal unsafe oxygen content and in cases of exclusion of contamination, it increases the significance of other established root causes. Thus, gas analysis should be a routine procedure in systematic investigations of scuba fatalities.

D 61

ORAL PRESENTATION TIME: 1354 - 1406
POSTER PRESENTATION TIME: 1530 - 1600
RESIDENT COMPETITION: NO

TRIATHLON DEATHS: SWIMMING-INDUCED PULMONARY EDEMA?

Martina SD, Peacher DF, Otteni C, Moon RE
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Introduction/Background: Triathlon deaths occur mostly during the swim portion of the race with unknown cause. Swimming-induced pulmonary edema (SIPE) is usually reported during scuba diving and surface swimming, with a prevalence of 1.5% among triathletes (Miller CC. *Am J Emerg Med.* 2010;28:941). We have demonstrated high pulmonary vascular pressures during immersed exercise in SIPE-susceptible individuals, possibly due to decreased left ventricular diastolic compliance (Peacher DF. UHMS 44th Sci Mtg, F128, 2011). In order to determine whether SIPE may cause some of these deaths we looked for risk factors for high pulmonary vascular pressure, including LVH, which can cause diastolic heart failure. We hypothesized that LVH is present in a disproportionate number of triathlon deaths.

Materials and Methods: We searched EMBASE and Google for triathlon deaths from October 2009 to present. After institutional approval, autopsy reports were reviewed for causes of death and cardiovascular risk factors. We compared the prevalence of LVH in the study population with the normal population and triathletes using chi square test for statistical significance.

Results: We identified 41 deaths, 36 of which occurred during the swim portion, and obtained 18 autopsy reports. Mean age was 46.6, range 33-64 years. Mean BMI was 28.5 kg/m^2, range 17.9-38.3 kg/m^2. LVH was the most prevalent cardiovascular condition (n=10, 56%), followed by CAD (n=6, 33%). A history of hypertension was reported in four individuals and atrial fibrillation was reported in one individual. The prevalence of LVH was significantly higher among the reviewed autopsies compared with the general population (16%, P<0.001) (Levy D. *Am J Cardiol.*1987;59:956) and triathletes (24%, P<0.001) (Douglas PS. *Am J Cardiol* 1997;80:1384).

Summary/Conclusions: Our data are comparable to a similar published series (Harris KM. *JAMA.* 2010;303:1255).We conclude that some deaths during the swim portion of triathlons may be caused by SIPE.

D 62

ORAL PRESENTATION TIME: 1406 - 1418
POSTER PRESENTATION TIME: 1530 - 1600
RESIDENT COMPETITION: NO

EFFICACY OF THE U.S. NAVY DIVE / TREATMENT TABLES IN TREATING DCS IN 103 RECREATIONAL SCUBA DIVERS

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Introduction/Background: Despite current decompression models reducing the risk of decompression sickness (DCS), recreational divers continue to be affected. Because of its nonspecific symptoms, treatment can be delayed and lead to incomplete symptom resolution. Our study aims to understand the efficacy of U.S. Navy treatment tables (TT) in treating DCS.
Materials and Methods: A single center retrospective chart review was conducted from 2003-2013. Exclusion criteria included incomplete chart, arterial gas embolism, treatment delay>14 days, aborted treatment, and first treatment not completed at UCLA. 187 subjects were identified, 84 were excluded. 103 subjects' charts were independently reviewed by two researchers. Symptom resolution at the end of treatment was categorized as complete relief (no clinical symptoms reported by patient), partial relief, or no relief of symptoms. Data was analyzed with STATA; Spearman rank (r_s) was used to analyze correlation.
Results: Of 103 cases included, 76 males and 27 females had an average of 3 dives (range:1-20) and 2.47 HBO treatments (range:1-10). 51.5% felt complete resolution (46 DCS type II;7 DCS type I), 43.7% felt partial resolution (40 DCS type II;5 DCS type I), and 4.8% felt no resolution (3 DCS type II;2 DCS type I). Of the 53 patients having complete resolution, 30.2% needed only one HBO treatment while 69.8% needed at least two. 47.6% (N=49) of patients felt symptomatic relief during the first 10 minutes of therapy but only 53.1% (N=26) of those patients, had complete relief at the end of all therapy.

		Resolution after 1st treatment N=103	Number of HBOT Treatments N=89	Symptom Relief at 10min at 60 FSW	Type of DCS	Treatment Delay
Resolution of Symptoms at end of HBOT	r_s	0.448	0.223	None	None	None
	p value	0	0.036			
	correlation	moderate, positive	weak, positive			

		Number of HBOT Treatments	Symptom Relief at 10min at 60 FSW
Resolution after 1st treatment	r_s	0.382	0.212
	p value	0	0.032
	correlation	weak, positive	weak, positive

Conclusion: No strong correlations were found between variables. These TT proved partially effective for recreational divers as only half achieved complete resolution at the end of therapy. Change of symptoms with the first TT was not a good indicator of overall outcome. We suggest that TT be further investigated for recreational divers.

D 63

ORAL PRESENTATION TIME: 1418 - 1430
POSTER PRESENTATION TIME: 1530 - 1600
RESIDENT COMPETITION: NO

FLUID LOADING BEFORE IMMERSED EXERCISE AND CHANGES IN SPIROMETRY AS A SCREENING TEST FOR SUSCEPTIBILITY TO SWIMMING-INDUCED PULMONARY EDEMA (SIPE)

Moon RE, Martina SD, Natoli MJ, Schinazi EA, Scafetta N, Derrick BJ, Viola JH, Medford M, Moffat A, Freiberger JJ
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Introduction: Reductions in FVC, FEV_1 and FEF_{25-75} have been observed in SIPE-susceptible individuals after a 2.4 km swim (A Shupak, Respir Physiol 2000;121:25). We hypothesized that SIPE-susceptibility could be identified by measuring spirometric values before and after 40 minutes of head-out immersed exercise in cold water with or without fluid loading.

Methods: After institutional approval and informed consent spirometry was performed before and after 40 minutes of moderate exercise without thermal protection in 20°C water. Subjects included 14 individuals who had experienced one or more episodes of SIPE (SIPE-susceptible, **S**) and 37 normal volunteers who had never experienced SIPE (controls, **C**). A subset of 9 **S** and 7 **C** were studied on another day after ingesting 2 L of Pedialyte™ (Abbott Nutrition, Columbus, OH: ingredients Na 45 mEq/L, K 20 mEq/L, Cl 35 mEq/L, citrate 30 mEq/L, glucose 139 mM/L, osmolality 250 mOsm/kg). Statistics were performed using Fisher's exact test.

Results: Two of 14 **S** developed symptoms of SIPE during the study vs. none of **C** (P=0.06), and one **S** had to stop prematurely. After hydration, 6/9 **S** developed symptoms of SIPE during the immersed exercise period vs. none of **C** (P=0.01). Four of the 6 stopped prematurely. Individuals exhibiting ≥10% reduction in the given parameters are shown in the Table.

	Control		**Fluid Loading**	
	C, N=37	**S, N=14**	**C, N=7**	**S, N=9**
FVC	1 (3%)	2 (14%)	0 (0%)	5 (56%)*
FEV_1	4 (11%)	4 (29%)	0 (0%)	8 (89%)§
FEF_{25-75}	11 (30%)	1 (29%)	3 (43%)	7 (78%)

*P=0.03; §P=0.001

Conclusions: Fluid loading with an electrolyte solution increases the risk of developing SIPE. A 10% or greater reduction in FEV_1 after a 40 minute exercise in 20°C water after ingesting 2 L of Pedialyte™ is a possible screening test for SIPE susceptibility.

Acknowledgements: *Supported by NAVSEA Contract #N0463A-10-0005.*

D 64

ORAL PRESENTATION TIME: 1430 - 1442
POSTER PRESENTATION TIME: 1530 - 1600
RESIDENT COMPETITION: NO

SWIMMING-INDUCED PULMONARY EDEMA (SIPE) SUSCEPTIBILITY AND CARDIAC FUNCTION DURING IMMERSED EXERCISE

Moon RE, Kisslo JA, Martina SD, Natoli MJ, Schinazi EA, Scafetta N, Armour A, Rivera D, Risum N, Viola JH, Medford M, Moffat A, Freiberger JJ
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Introduction: The pathophysiology of SIPE is not fully understood, but evidence suggests that it is due to high pulmonary vascular pressures in susceptible individuals, which we hypothesized is due to reduced LV diastolic compliance.

Methods: After institutional approval and informed consent, 219 normal volunteers (**C**) were screened to identify 83 individuals with a TR jet, of whom 40 were studied with transthoracic echocardiography (TTE) during head-out immersion in 20°C water, during rest and 40 minutes of moderate exercise. Fourteen individuals with prior SIPE (**S**) were studied similarly. Measurements were obtained at rest in the dry (**DR**) and immersed (**IR**) then early (**IE1**) and late (**IE2**) during immersed exercise. Statistical analysis was performed using Wilcoxon signed rank test.

Results: Asterisks in the Table indicate parameters in which **S** differed from **C**.

Parameter	DR	IR	IE1	IE2	Parameter	DR	IR	IE1	IE2
Aortic velocity time integral (AoVTI)	*		*	*	LV end-syst volume		*		*
AoVTI x HR				*	Mitral flow A wave				*
e' AVG Sep-Lat	*	*			Mitral flow E wave	*	*		*
E/e'	*	*	*	*	PA ejection time		*		
IVC dia expiration		*	*		Time to peak PA flow/PA ejection time		*		
IVC dia inspiration		*	*	*	PA velocity-time integral x HR		*	*	*
IVC exp/insp ratio		*	*	*	Pulmonary vein D wave				*
LV fract shortening		*			RV syst pressure	*		*	*
Early diastolic mitral annular veloc (lateral)		*		*	Tricuspid annular plane syst excursion	*	*		
Early diastolic mitral annular veloc (septal)		*			TR velocity	*		*	*
LVEF	*	*		*	Peak syst tricuspid press grad			*	*

Conclusions: TTE can be used to identify SIPE-susceptible individuals. These data suggest that in **S** higher pulmonary vascular pressures is due to impaired diastolic filling.

Acknowledgements: *Supported by NAVSEA Contract #N0463A-10-0005.*

D 65

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1530 - 1600
RESIDENT COMPETITION: YES

FACTORS AFFECTING ADHERENCE TO PRE-DIVE CHECKLISTS: A NESTED STUDY

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Use of pre-dive checklists can reduce the incidence of mishaps in recreational scuba diving, and hence may also prevent injuries and fatalities. However, the prevalence of checklist use remains low. It is important to understand the environmental and individual factors that promote or deter checklist use. Such an understanding will allow us to better promote pre-dive-checklist-use. In summer 2012, 617 divers were enrolled in the intervention arm of a cluster randomized trial and were provided pre-dive checklists to use. About 30.3% divers (n=187) did not adhere to the trial-checklist. Exploratory logistic regression analyses were used to model adherence to pre-dive checklist with generalized estimating equations to control for the non-independence between divers diving on the same location-day. Factors associated with greater adherence were customary use of a checklist, older age, and higher average annual dives. Factors that were associated with lower adherence were female sex, non-white race, and diving in North Carolina. As compared to the divers who do not use checklist routinely, the divers who do were 2.5 times adherent to the trial-checklist. Older adults (more than 35 years of age) adhered to the trial-checklist 67% more than the younger adults (18-35 years of age). Those who dove in North Carolina adhered to the trial-checklist 58% less than those who dove in the Caribbean. Adherence to checklist-use is also a function of risk perception, facilitators, and barriers. Future studies should try to understand diver risk perceptions, promote facilitators, and reduce barriers to promote the use of pre-dive checklists.

D 66

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1530 - 1600
RESIDENT COMPETITION: YES

FACTOR ANALYSIS ON NEMO 33 PRE AND POST DIVE PHYSIOLOGICAL DATA

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Introduction: This study investigates the physiological measurement data acquired during Nemo 33 diving pool in the scope of the Phypode (physiopathology of decompression) Project. Various physiological measurements such as blood tests, urine tests, impediometry measurements, ecographies etc. were taken before and after dives. As the result, the dataset obtained consisted of numerous and interrelated variables that needed to be analyzed against redundancies and correlations to be used for statistical inferences.

Method: In 1999 and 2012, 32 divers performed a total of 252 no deco dives to 33 meters for 20 minutes in Nemo 33. Physiological measurements were taken before and after dives. A dataset of 46 different physiological measurements with pre and post dive differences is obtained. After excluding the missing data, 21 variables and 146 cases remained for the analysis. This data is subjected to exploratory factor analysis to clean out the interdependences and to reduce the number of variables by finding the common factors affecting them.
For the extraction of common factors, Principal Components Method is used and the factors are rotated orthogonally by Varimax Rotation. Similar analysis is applied to pre and post dive differences using the variables that changed significantly after dives

Results: Five common factors representing the 21 variables explained 70.035% of total variance among variables. The scores of divers for the 5 factors and the factor score coefficients are calculated allowing the use of common factors at the place of original variables with a loss of 29,965% of variance among variables. Factor analysis on pre and post dive differences yielded 4 common factors explaining 72,890% of total variance.

Conclusion: The common factors are uncorrelated and suitable for subsequent analysis such as linear regression. Additionally, revealing the underlying the common factors affecting different subsets of physiological data, permitted determining the groups of correlated variables.

D 67

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1530 - 1600
RESIDENT COMPETITION: NO

A PILOT STUDY ON DIVING ACCIDENTS IN TURKEY

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Background: Diving accidents can be minimized if the contributing factors and the causes are clarified. An investigation of a diving accident should include on-scene investigation, forensic investigation, equipment testing etc. In Turkey, there has been no study analyzed diving accidents and currently there is no database that includes accidents recording system. The documents about diving accidents presumed to be kept at Turkish Underwater Federation, court houses and autopsy departments. In this study it is aimed to reach and review the documents regarding diving accidents at the institutions mentioned above.

Materıals and Methods: Related permissions were taken to scan the archives that may include documents regarding diving accidents. The documents reached were investigated to find out the possible contributing factors for the diving accidents, to clarify the causes of accidents, to detect the cause of death or injury, and finally to find out if the documents include the necessary records that should be kept in diving accidents.

Results: In the first step of the study, files about 12 diving accidents were reached at the archives of Turkish Underwater Federation. Nine accidents were resulted fatal, and in the other three accidents the divers survived without residue. The documents in the files were insufficient and the divers involved in seven of the accidents were novice divers. Seven accidents were occurred relatively shallow depths ranged between 4-20 m. Two of the deceased divers were over 60 years old. Somehow, uncontrolled ascent was noticed in majority of the accidents.

Conclusıon: This preliminary study indicated the need for standard procedures for investigating diving accidents which should include history of diving, on-scene investigation, equipment testing, medical and forensic investigation. More data will be evaluated when the documents were reached at court houses and autopsy departments.

D 68

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1530 - 1600
RESIDENT COMPETITION: NO

A CASE OF IMMERSION PULMONARY EDEMA PRESENTS AS ACUTE CORONARY SYNDROME… OR DID IT?

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Introduction: Immersion pulmonary edema (IPE) is being diagnosed more frequently and even implicated in a diver's death. It is not taught to physicians or divers; and this knowledge gap can lead to misdiagnosis, putting patients at risk and costing the system.

The case: 62 y/o male, day 3 of a diving vacation, dove to 65fsw. After 20 minutes, he felt short of breath. Skipping the safety stop, he surfaced, gasping for air. He denied chest pain or tightness. "When I surfaced, I had foam coming out of my mouth". Symptoms improved on Oxygen. He was brought to the ED.

ED Chart:
"Arrived in no distress", VS: Sats: 97% on O2, 87% on RA
Exam: "cyanotic when O2 removed, rales bilaterally"
Chest x-ray: "showing data of congestive lungs"
Troponin: Negative

Pt was flown to Florida. Cath: severe 3-vessel CAD (chronic w/ extensive collaterals), taken to OR for CABG x5. On POD #3 he developed A-Fib, was chemically cardioverted and discharged on Amiodarone and Pradaxa. Peak Troponin: 0.2.

Aftercare: he routinely reaches 8 mets for 30-60 minutes without symptoms. He has stopped Predaxa due to nosebleeds, and c/o side effects from beta-blockers.

Total cost: $494,000

Discussion: IPE can have a classic history and physical when one asks the right questions. It can, however be misdiagnosed due to inadequate knowledge. While ACS is certainly a more debilitating process than IPE overall, misdiagnosis can be very costly and subject patients to risky therapies. Even when the respiratory aspects were noted, this patient was still tracked into a coronary pathway, medevaced to the US, cathed and started on a six-month rehabilitation routine.

Conclusions: IPE is potentially life-threatening and likely missed by physicians not aware of it. Efforts to close this knowledge gap and improve awareness of IPE are essential to avoiding misdiagnosis and improving outcomes.

D 69

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1530 - 1600
RESIDENT COMPETITION: NO

HEALTHY DIVERS IN HEALTHY OCEANS: UCSD SAN DIEGO CENTER OF EXCELLENCE IN DIVING (SDCED)

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Introduction: The challenges and need for the establishment of the world's first academic center of excellence dedicated to understanding the complex interactions of diving physiology with the environmental issues affecting divers' health has been met by the University of California San Diego. UCSD Health Sciences and UCSD Scripps Institution of Oceanography's expertise in diving medicine and marine science combined in identifying San Diego as the desirable location for this initiative, characterized by a critical mass of diving medicine specialists and marine researchers, home to diving industry corporations, and with expedient ocean access.

Objectives: SDCED aims to create knowledge and improve competencies in recreational, scientific, commercial, military, and public safety diving. In support of "*Healthy Divers in Healthy Oceans*" SDCED emphasizes support of diving medical research, education, and training throughout the world's oceans for the benefit of all divers.

Outcomes: SDCED advances an interdisciplinary agenda to pursue cutting-edge, innovative research in diving physiology, medicine and ocean conservation while building a complimentary bridge between the diving medical and marine science communities. SDCED functions as a cross-cutting international platform reinforcing a combinatorial effect towards improving divers' health and fitness and the health of the ocean environments they are diving in. Deliverables are in the form of peer-reviewed and popular publications, convening of international, interdisciplinary symposia on diving medical and marine science topics as they relate to diver health, and the organization of a "Diving Citizen Scientist" program that coordinates global projects of participating recreational and technical divers to census and monitor "*Health Divers in Healthy Oceans.*"

D 70

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1530 - 1600
RESIDENT COMPETITION: NO

BREATHING PROBLEMS UNDERWATER ARE COMMON IN THE COMPRESSED GAS DIVERS, A RETROSPECTIVE STUDY

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Introduction/Background: Immersion Pulmonary Edema (IPE) is a poorly understood and potentially fatal malady that affects swimmers, divers, men and women. The one ubiquitous symptom that these patients experience is difficulty breathing. This study was designed to determine the frequency of breathing problems in a group of experienced divers.

Materials and Methods: Attendees at a regional diver's education meeting were asked to complete a 19 question questionnaire about the frequency of breathing problems experienced underwater, their diving experience, usual diving environment, age and gender. The data was compiled and analyzed using Chi-squared and analysis of variance (ANOVA) where indicated.

Results: 32% of attendees completed the forms with 19% of respondents reporting at least one episode of difficulty breathing underwater. 62% of those affected reported more than one incidence of breathing problems. The two groups did not differ in terms of age ($p=0.11$) experience ($p=0.31$), or deepest dive depth ($p=0.15$). There was some evidence that divers who experience breathing difficulty have greater usual depth than divers without difficulty (average usual depth 78 fsw vs. 60 fsw $p=.052$). Also those who reported using rental regulators had a higher rate of breathing problems than those who owned their gear ($p=0.05$), and a trend that women had a lower incidence of breathing problems then men ($p=0.08$), though their deepest dive was shallower than their male counterparts (123 fsw vs. 176 fsw $p=.017$).

Summary/Conclusions: While not all breathing problems are IPE the fact that 19% of respondents (6% of paid attendees) have experienced breathing problems underwater is significant. While equipment problems are often "blamed" for breathing problems, 95% of respondents who own regulators have them serviced at regular intervals, making this a less likely cause. Further investigation into (and the contribution of resources towards) this topic and IPE is clearly warranted.

D 71

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1530 - 1600
RESIDENT COMPETITION: NO

SEIZURE FOLLOWING HYPERBARIC TREATMENT FOR DECOMPRESSION SICKNESS

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Background: Oxygen toxicity seizure is a recognized side effect of hyperbaric oxygen treatment. We report the case of a patient who experienced loss of consciousness followed by several hours of confusion and combativeness, approximately 10 minutes after completing a USN Table 6 for decompression sickness.

Case Presentation: An experienced 53-year-old diver completed two uneventful, no-decompression dives on 32% nitrox using a dive computer. The first dive was to maximum depth 90' with total dive time 73 minutes and the to 79' maximum over 65 minutes, with a 109 minute surface interval. Within an hour of completing the dives, she developed weakness, hip pain, epigastric discomfort, nausea, and vomiting. Oxygen and IV fluids were administered and she was transferred to a local emergency department where she received IV ondansetron and ketorolac. Evaluation showed no apparent cause for the symptoms and the patient was transferred to our facility for treatment of decompression sickness. She received a USN Table 6 with 2 extensions at 60' without incident and resolved all symptoms.

Ten minutes after leaving the chamber, she became acutely altered and developed unresponsiveness followed by confusion and combativeness for several hours. CT, MRI, toxicology screen, LP, laboratory tests and neurologic consultation were notable only for serum sodium 123. She was hospitalized and fluid restricted with normalization of neurologic status and serum sodium within 36 hours. Follow-up neurological exam and EEG were unremarkable.

Discussion: In the absence of an alternate explanation, the patient was felt to have had a seizure contributed to by hyponatremia. The patient described drinking "lots of water" throughout her prehospital and ED course. Serum sodium was 134 at the initial ED 12 hours earlier. She was documented to consume 2,200 ml of water during her hyperbaric treatment. We believe that excessive consumption of free water caused transient hyponatremia, leading to a seizure-like event.

We encourage rehydration with electrolyte-containing solutions and avoidance of excessive free water during management of decompression sickness in an effort to avoid this rare complication.

D 117

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1530 - 1600
RESIDENT COMPETITION: NO

LIONFISH STINGS TREATMENT COMPLICATIONS IN DIVERS

Gomez-Castillo JD
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Introduction: Treatment for lionfish stings (Pterios volitans) has been widely spread trough the Caribbean due to the invasion of this non native species. Treatment considerations have to bee well specified to responders as accidents are more frequent and complications with treatment can present, although not life threatening can cause more harm the original injury.

Methods: We collected data form patients that had accidental envenomations by lion fish stings, from lionfish fishing tournaments where we provided medical care and patients admitted the emergency room of the General Hospital of Cozumel. Cases were noted over a time period of 4 years. Follow up of cases with complications were done at one, two weeks, one and two months.

Results: A total of 41 cases of patients with envenomation were attended, although no complications from the stings were reported on the 41 cases, we had 3 cases where the divers had burns from hot water treatment of different degrees. One of the patients developed a severe infection after burn and resuming scuba diving too early. This case needed medical and surgical treatment with reconstruction of first finger, with partial loss of function.

Conclusion: Many resources will suggest the water needs to be between 100°-115°F, but there really is no practical way to measure that or time to get water to the correct temperature in most instances. Immersing the wound in water that is as hot as the victim can stand without scalding or burning the skin is a usual recommendation, but patients with this kind of injuries are impaired to discern temperature properly. Responders and divers should be aware of this fact to avoid this kind of complications.

PLENARY: *Reflections on the Neurotherapeutic Effects of Hyperbaric Oxygen*

Shai Efrati, MD

1600 - 1700

About the Lecturer:
Shai Efrati, MD

Shai Efrati is the ***head of the hyperbaric institute*** at Assaf-Harofeh medical center. Assaf-Harofeh, one of the biggest governmental hospitals in Israel, affiliated to Sackler School of Medicine of Tel-Aviv University. The hyperbaric institute includes 2 multi-chambers and monochambers currently treating around ***100 patients per day***. From December 2014 the hyperbaric institute will have additional facilities that will enable treatment of ***200 patients per***.

Shai Efrati is also the ***head of the Research & Development unit*** of the hospital. The R&D unit includes laboratories for basic science, pre-clinical studies as well facilities needed for phase I/II clinical trials. One of the major issues investigated in the unit is related to thermodynamic/metabolic interventions in different organs damage.

Shai Efrati is currently leading a research program aiming to evaluate the applied perspectives of the use of HBOT for different brain injuries. The research group devoted for this program includes physicians, neurobiologists, physics, neuropsychologist and imaging/data analyst's specialists and bio-statistics.

The first 2 clinical studies on post stroke and post concussion patients were published in the last year. Additional studies focusing on neurocognitive dysfunction and pain related central sensitization are currently ongoing.

Shai Efrati has more than 70 scientific publications.

About the Lecture:
Reflections on the Neurotherapeutic Effects of Hyperbaric Oxygen

Traumatic brain injury (TBI) and stroke are the major causes of brain damage and chronic neurological impairments. There is no agreed-upon effective metabolic intervention for TBI and stroke patients with chronic neurological dysfunction. Clinical studies published this year present convincing evidence that hyperbaric oxygen therapy (HBOT) can be the coveted neurotherapeutic method for brain repair. In the lecture we will discuss the multi-faceted role of HBOT in neurotherapeutics, in light of recent persuasive evidence for HBOT efficacy in brain repair and the new understanding of brain energy management and response to damage. We will discuss optimal timing of treatment, dosage, suitable candidates and promising future directions. "Pressure rise Oxygen" is not a simple "drug" and based on new physiological knowledge it is quite clear that many of the conflicting results in clinical trials can be attributed to misleading methodologies. These issues, in addition for the need of the hyperbaric community to rethink the HBOT neurotherapeutic effects and to agree on common and scientifically sound guidelines to best conduct prospective, controlled HBOT clinical trials will be discussed. We envision future studies that will demonstrate the effectiveness of HBOT for a wide spectrum of syndromes that currently have partial or no solution, such as central sensitization (Fibromyalgia), vascular dementia and other metabolic aging effects.

SATURDAY
JUNE 21

SESSIONS
E & F

PLENARY: *International Perspective on Hyperbaric Oxygen*

Ken LeDez, MD & Panel

0800 - 0930

About the Lecturer:
Kenneth LeDez, MD

Dr. LeDez is the first President of, and led the successful establishment of the Canadian Chapter of the UHMS, overcoming many challenges to do so. He started the hyperbaric medicine service in Newfoundland and Labrador in 1992 after completing a hyperbaric fellowship in 1987 followed by working as a staff hyperbaric physician in Toronto. He is recognized as a specialist in Diving and Hyperbaric Medicine by Canada's offshore petroleum industry and regulators and provides medical coverage and consulting for offshore diving operations. He was academic chair of anesthesiology at Memorial University in Newfoundland, on the editorial Board of the Canadian Journal of Anesthesia for nine years and was a member of the Executive Board of the Canadian Anesthesiologists Society. He has served on many national level committees in Canada and continues on the Standards of Practice Committee and Research Committee for the Canadian Anesthesiologists Society. He is secretary of a subcommittee of the International Standards Organization technical committee on anesthesia and respiratory equipment and a member of the Canadian Standards Association anesthesia committee. In writing the Bylaws and working with the UHMS to set up the Canadian Chapter he realized that the UHMS needs to make changes to become stronger and grow. Changes to the constitution and bylaws may benefit the Society. The UHMS needs to be stronger on the ground in the USA (consideration of regional organizations and more local chapters) and to better define relationships with chapters that are national organizations such as the Canadian and Brazilian Chapters. This will enable international growth for the UHMS to better fulfill the international role envisaged by the founders of the Society. National chapters and chapters within the USA should be consulted and have a role in building the UHMS. Dr. Ken LeDez emphasizes the importance of standards of care and research in order to secure the future of hyperbaric medicine.

About the Lecture:
International Perspective on Hyperbaric Oxygen

SESSION E

HBO_2 Therapy, Chamber and Equipment

E 72

ORAL PRESENTATION TIME: 1000 - 1012
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: NO

INDOCYANIN GREEN ANGIOGRAPHY (ICGA) DEMONSTRATES ANGIOGENIC EFFECT OF HYPERBARIC OXYGEN THERAPY

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Introduction: ICGA is a new imaging technology with the potential to change the way we monitor the angiogenic effects of hyperbaric oxygen therapy. ICG is a fluorescent dye that is injected intravenously via a peripheral IV. It binds to plasma proteins and is confined to the intravascular space. It has a half-life of 3-4 minutes so multiple images can be obtained in relatively short order. It is hepatically metabolized and can be given to patients with renal insufficiency. Quantitative analysis can be done using calculations of Ingress and Ingress Rate of ICG.

Methods: We performed ICGA on a series of patients before and after they received a series of hyperbaric oxygen therapy. Three patients were getting treatment for Wagner 3 diabetic foot infections. Two patients were getting treatment for chronic radiation tissue injury to the sacrum.

Results: Post-hyperbaric oxygen images showed subjective increases in the brightness of the ICG uptake as well as in the total surface area of uptake. This correlated with a clinical improvement of the patients' wounds. Quantitative measurements did not correlate with qualitative observations.

Discussion: These images show that a greater amount of ICG dye was seen in post-hyperbaric images than pre-hyperbaric images. The brighter intensity of the images is thought to correlate with increase angiogenesis and a positive response to hyperbaric oxygen therapy. Several confounders exist, however, including variations in dosing of the ICG dye, positioning of the camera, or factitious results due to external factors.

Conclusions: ICGA has the potential to visually demonstrate capillary angiogenesis, something that we have extrapolated from transcutaneous oxygen measurements. Routine use of ICGA could become standard practice to demonstrate a positive response to hyperbaric oxygen therapy. More rigorous studies need to be conducted to verify these results, including standardized testing protocols in order to avoid factitious results.

E 73

ORAL PRESENTATION TIME: 1000 - 1012
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: NO

CONFOUNDING FACTORS IN THE INTERPRETATION OF INDOCYANIN GREEN ANGIOGRAPHY (ICGA)

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Introduction: ICGA is a new imaging technology with the potential to change the way we monitor the angiogenic effects of hyperbaric oxygen therapy. ICG is a fluorescent dye that is injected intravenously via a peripheral IV. It binds to plasma proteins and is confined to the intravascular space. Quantitative analysis can be done using calculations of Ingress and Ingress Rate of ICG. There are many variables that have not been fully evaluated with regard to testing protocols, so we undertook an evaluation process to identify potential confounding factors in the interpretation of ICGA.

Methods: We evaluated the variability of ICGA by performing testing protocols investigating parameters of interest: 2 subjects over different time points; different doses of ICG on the same subject at the same visit; immediately before and immediately after a hyperbaric oxygen treatment; and immediately before and after transcutaneous oximetry of the foot.

Results: There was minimal subjective and objective variability between studies of each subject. ICG uptake was lower than expected in “normal feet.” There was subjective and objective variability based on dose of ICG. There was neither subjective nor objective variability after an acute hyperbaric oxygen treatment. There was a subjective change in the image after transcutaneous oximetry, but no change in the objective measurement.

Conclusions: Some test results were reproducible; however, we did see variability that raised concerns about how to interpret the repeated studies. ICG is drawn up for each study from a multi-use bottle, leading to potential error. A single hyperbaric oxygen session does not appear to have a demonstrable effect. TCOM testing causes hyperemia in the site of the probe, which can be seen if ICGA is performed immediately afterwards. More rigorous studies need to be conducted to verify these results, including standardized testing protocols in order to avoid factitious results.

E 74

ORAL PRESENTATION TIME: 1048 - 1100
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: NO

LATERAL APPLICATION TO ACCELERATING PATIENT FLOW IN THE HYPERBARIC CHAMBER

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Introduction: What is the one consistent issue that our patients' dislike the most about HBOT?………WAITING.

The market audience is convenience driven, time poor and motivated to move on if their needs are not being met. Clinical staff can become immune to patient delay. Process improvement is more transparent when you stop looking at staff and start looking at your patients.

Methods: This patient flow concept is for a three compartment multi-place chamber and our unit is the model. This process is for a 14 msw/ 46 fsw therapeutic table, with two routine treatments daily.

The concept is simple, once the main compartment has dived to treatment depth (with the first group of patients) at the start of the day, that main compartment then remains at treatment pressure up until the final patient group arrives back on surface at completion of the day's final treatment.

After analyzing patient/staffing models, patient arrival times were staggered and patient groups reduced to (up to) four, vice the usual, (up to) eight. These smaller patient groups are then transferred into the main compartment via the smaller treatment compartment at 30 min (and varying) intervals. This process is repeated until the final patient group completes treatment and surfaces via the main compartment.

Results: We theoretically calculated a patient wait time saving of up to 28% (26.6 Hrs over 40 routine treatments). More Doctor and Nurse face time for patient's, which equates to better patient quality care outcomes – less chance of mistakes.

Other savings determined: 25-30% reduction in running costs of the chamber facility; 15% reduction in oxygen costs for patient treatments; 100% reduction in oxygen costs for inside attendants (No Deco obligation).

Summary: We intend to trial this new model in the near future and may reasonably estimate greater patient satisfaction, improved efficiency and business growth.

E 75

ORAL PRESENTATION TIME: 1024 - 1036
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: NO

ADJUSTABLE LENS EYEGLASSES FOR VISUAL CHANGES ASSOCIATED WITH HYPERBARIC OXYGEN TREATMENT

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Introduction/Background: Hyperbaric Oxygen Treatments (HBOT) trigger visual changes. These can compromise safety in jobs/situations requiring good visual acuity (driving). We measured the visual changes during HBOT and assessed the ability of adjustable glasses to correct them.

Materials and Methods: Visual acuity (Snellen chart) and refractive error (Nidex AR-310A autorefractor) were measured on all patients expected to complete more than 10 HBOTs. Testing was done prior to starting HBOT and again after 15, 30 and 40 treatments. Patients who reported visual changes that interfered with their daily lives were offered adjustable lens glasses (Adlens-Hemisphere), and completed a questionnaire about their experiences with them.

Results: Visual acuity and refraction data were collected on 26 patients. Eleven had complete baseline, 15 and 30 day data on at least 1 eye (see table below). Data presented as mean ± S.D. P values (repeated measures ANOVA with Bonferroni post hocs) reflect comparison to baseline.

	Baseline	15 days	30 days
Acuity (n=20 eyes)	20/36± 20.8	20/40 ± 24.6	20/52± 26.7 p<0.003
Sphere (n=21 eyes)	0.9±1.4	0.6±1.8 p=0.003	-0.2±1.6 p<0.0001

Patients became more myopic. Significant changes were detectable after 15 HBOTs. Eight out of 18 patients who completed at least 15 HBOTs reported visual changes. Four patients opted to use the glasses: 3 to improve distance vision for watching television and driving, 1 for reading and computer work. The glasses corrected the visual changes. The major drawback was aesthetic. This model of adjustable glasses had prominent adjusting knobs that were not removed.

Summary/Conclusions: Visual changes occur commonly with HBO treatments, although many patients are either not aware of them or feel they are not significant enough to require action. Adjustable lens glasses correct vision in this setting, which can be very important for patients in jobs/situations requiring good visual acuity. The comfort and appearance of the glasses could be improved.

E 76

ORAL PRESENTATION TIME: 1036 - 1048
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: YES

HYPERBARIC OXYGEN (HBO_2) IN PATIENTS WITH DELAYED VENTILATION

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Introduction/Background: Delayed ventilation may increase a patient's risk for pulmonary barotrauma (PBT) during hyperbaric oxygen (HBO_2) therapy decompression, which can be lethal. Pulmonary risk stratification to screen for delayed ventilation in patients eligible to undergo HBO_2 has not been formalized, perhaps because PBT occurrence in HBO_2 is low.

Methods: We developed an algorithm for pulmonary risk assessment of HBO_2 patients in 2005 to include ventilation scanning. To determine its adherence and utility, we performed a retrospective review of patients treated at two hyperbaric facilities (Intermountain LDS Hospital and Intermountain Medical Center). For patients identified as at-risk for PBT (history of emphysema, asthma, radiation therapy, lung cancer, nodules, pneumonia, lung trauma, surgery, and smoking), we assessed algorithm adherence, evaluation results, and complications with HBO_2.

Results: From 1/2005 to 2/2014 we identified 92 patients at risk for PBT by medical history. These patients subsequently underwent chest radiography (65), Pulmonary Function Testing (32), chest CT (29), and/or ventilation scans (44) to evaluate PBT risk. Of these 92 patients, 26 were not treated with HBO_2, 7 for compromised pulmonary status prior to formal PBT risk assessment; the other 19 did not have an indication, had cardiac risk, or were lost to follow-up. Of 66 patients receiving HBO_2, 10 discontinued HBO_2 early with 2 for possible pulmonary issues (1 acute pulmonary edema, 1 "breathlessness"). Of 92 patients, 44 had ventilation scans for air trapping, with 28 patients showing delayed ventilation (>5 minute delayed washout). Of the 28 patients with delayed ventilation, 26 had uneventful HBO_2 treatments (726 total sessions), while the remaining two did not receive HBO_2. One of them had >40 minutes of washout and cardiac risk factors; the other had >20 minutes washout, and declined HBO_2 because of bullous disease.

Conclusions: Carefully screened patients with delayed ventilation may be treated safely with HBO_2.

E 77

ORAL PRESENTATION TIME: 1012 - 1024
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: NO

HYPERBARIC OXYGEN THERAPY FOR THE CRITICALLY ILL: HOW SAFE IS IT?

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Introduction: Despite the number of approved indications for HBOT, many critically ill patients continue to go untreated because of the physician's lack of confidence in the safe treatment of these patients in the HBOT environment.The purpose of this study is to evaluate the safety of using HBOT for critically ill patients.

Method: A review of HBOT patient records between 2007 and 2012 was done for patients admitted to the surgical intensive care unit and medical intensive care unit. Demographic data, diagnoses for intensive care unit admission, diagnosis for HBOT, APACHE II score, SOFA score, SAPS II score, use of invasive tubes/lines and vasoactive medications were reviewed for all evaluable subjects.

Results: The HBOT patient charts (4733) were reviewed. Twenty-two evaluable subject charts were examined. Ages ranged from 22-82 years old with 13 males and 10 females. Indications for HBOT included necrotizing fasciitis (5), acute arterial insufficiency (1), mucormycosis (2), compromised graft/flap (5), cerebral air embolism (1), osteomyelitis (1), soft tissue radionecrosis (1), and carbon monoxide poisoning (6). HBOT treatment duration ranged from 3-40 treatments with treatments lasting 90-100 minutes at 2.0-3.0ATA. There were no adverse effects from HBOT. All subjects had at least one intravenous line and as many as four during HBOT. Three subjects had chest tubes and 4 subjects were on vasopressors while undergoing HBOT. Subjects' SAPS II scores ranged from 17-74 and SOFA scores ranged from 1-14 during HBOT. For the subjects with available APACHE II scores, 11 had a score equal to or less than 25, and 4 had a score of greater than 25. There was zero mortality during HBOT.

Conclusions: HBOT was safely utilized for critically ill patients in our study population. There were no adverse effects or mortalities associated with critically ill patients undergoing HBOT.

E 78

ORAL PRESENTATION TIME: 1100 - 1112
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: NO

QUALITY ASSURANCE: EVIDENCE OF EFFECT

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Introduction/Background: A Quality Assurance (QA) process is designed to systematically monitor and evaluate various aspects of a service to ensure that standards of quality meet specified requirements. In order to test the validity of this process, we undertook an analysis of key patient safety criteria prior to and following implementation of a focused QA screening tool.

Materials/Methods: A total of 30 charts were reviewed. Information was divided into specific indications/criteria. Initial evaluation involved medication reconciliation and accuracy of patient records. This resulted in the finding of a 79% overall compliance, with lower individual percentages for some specific criteria. Medication reconciliation of individual criteria yielded a compliance of 63% regarding provision of patient-specific lists upon discharge; 79% for reconciliation of medications on admission, which included allergies, doses, routes, frequency, and updating of new medications started or discontinued, and 83% provision of instructions upon discharge and transferring records to the next service provider. Accuracy of patient records yielded 35% for reassessment of care plans; 67% for proper wound documentation; 82% for patient education; 86% for medication administration documentation, and 100% compliance for authenticating orders and ensuring care provided matched orders.

Results: After QA implementation, a marked and uniform increase in compliance was noted. Reassessment of care plans increased to 83%, proper wound documentation and patient education to 100%, and medication administration documentation improved to 88%. Reassessment of medication list provision upon discharge increased to 100%, reconciliation of medications upon admission ranged between 77% - 92%, while providing discharge instructions and transferring records to next provider increased to 100%.

Summary/Conclusion: Implementation of a QA process provides tangible evidence of improved patient care and safety. It serves to ensure that patients receive higher quality care and helps to achieve and sustain compliance with regulations and standards necessary for maintenance of related licensure and accreditation.

E 79

ORAL PRESENTATION TIME: 1112 - 1124
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION:

CENTERS CAPABLE OF TREATING HYPERBARIC EMERGENCIES IN THE UNITED STATES

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Introduction/Background: Hyperbaric oxygen therapy is the primary treatment for arterial gas embolism, decompression sickness, and acute carbon monoxide poisoning. Though there has been a proliferation of hyperbaric centers throughout the United States, a scarcity of centers equipped to treat emergency indications makes transport of patients necessary. To locate and characterize hyperbaric chambers capable of treating emergency cases, a survey of centers throughout entire United States was conducted.

Materials/Methods: Using Google, Yahoo, HyperbaricLink, and the UHMS directory, a United States database was created. Four trained researchers called clinicians from the database to administer the survey. All centers were contacted for response until 4 calls went unreturned or a center declined to be included. The survey assessed chamber readiness to respond to high-acuity patients, including capabilities with ventilators or intravenous drug infusion, availability of 24 hour on-call staff, and confidence in managing in-chamber emergencies.

Results: Only 57 centers (18.45%, N = 309) reported being capable of using ventilators and intravenous infusion during HBOT for emergency indications in high acuity patients.

Survey Question	Result	#Centers	%Centers
Type of Center	Hospital Based:	248	**68%**
	Free-Standing Clinic:	97	27%
Type of Chamber	Monoplace:	290	**80%**
	Multiplace:	57	16%
	Both:	16	4%
On-Call Staff for Emergencies	Yes:	108	30%
	No:	201	55%
Use of IV-Pumps During HBOT	Yes:	90	25%
	No:	275	76%
Use of Ventilators During HBOT	Yes:	71	20%
	No:	292	80%
Confidence/Readiness of Staff and Facility at managing an in-chamber emergency	Confident:	291	94%
	Somewhat Confident:	13	4%
	Not Confident:	5	2%

Conclusions: Although 86 centers reported that they treat hyperbaric emergencies, only 57 centers had the equipment and staff to treat high acuity patients. Considering that a primary purpose of HBOT is the treatment of AGE and DCS, more hyperbaric centers nationwide should be able to accommodate these emergency cases quickly and safely.

E 80

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: NO

REDUCING THE RISK OF HYPERBARIC-INDUCED HYPOGLYCEMIA SEIZURE ACTIVITY

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Introduction/Background: Diabetic limb salvage management presents a significant challenge to wound care providers; one of the numerous approaches to encourage healing in these difficult wounds is the use of hyperbaric oxygen therapy. One of the challenges in treating hyperbaric diabetic patients is managing blood glucose at levels that don't impair healing while reducing the risk of dramatic reductions in blood glucose levels which commonly result in seizure activity.

Materials and Methods: We searched Medline and Cumulative Index to Nursing and Allied Health Literature databases using the following search terms; diabetes mellitus, glucose, keratinocytes, fibroblast, wound healing, re-epithelialization, HBO, and hyperbaric oxygen therapy. Surprisingly, no articles related to diabetic limb salvage and recommended blood glucose levels with or without hyperbaric oxygen therapy were found.

Results: We reduce the risk associated with by using a new protocol that reduced the incidence of seizure activity in the diabetic population undergoing HBO therapy. In 2012 Healogics Centers reports 24 seizures during 386,605 HBOT (14,283 Pts.). During 2013 they reported 14 seizures for 410,651 HBOT (15,346 Pts.). This new protocol resulted is a 58% decrease in seizure activity.

Summary/Conclusions: Careful glucose control is one of the most important actions health care providers can take to normalize healing and reduce seizure risks in diabetic patients. Poorly controlled diabetics experience delayed healing and when hyperbaric oxygen therapy is used, it often results in dramatic drops in blood glucose levels. We will discuss a new protocol that improves healing and reduces seizure activity to an incidence rate of 0.003%; far below any reported incidence rate to date.

E 81

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: YES

EFFECTS OF HYPERBARIC OXYGEN THERAPY ON BLOOD PRESSURE

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Introduction/Background: Hyperbaric oxygen (HBO) has been shown in prior studies to increase blood pressure. We sought to study the changes in blood pressure evoked by HBO.

Materials and Methods: We completed a retrospective chart review on patients treated March 1, 2012 – December 31, 2013 from prospectively obtained QA data on pre and post systolic, diastolic, and mean arterial pressures in patients undergoing HBO therapy. We recorded blood pressure, patient demographics, co-morbidities, anti-hypertensive therapy, and HBO treatment parameters.

Results: 96 patients underwent a total of 1815 treatments. There was a mean increase in MAP of 5.09 mmHg and median increase of 5.61 mmHg. There was no significant difference in MAP change between patients with a history of hypertension and no hypertension. In the subgroup of patients with hypertension, the type of anti-hypertensive medication made no difference in MAP change. Co-morbid conditions were not associated with a change in MAP during HBO. The mean change in MAP for 90 minutes (5 mmHg) and 120 minutes (6.59 mmHg) was significant ($p=0.011$). The mean change in MAP for 2.0 ATA (7.34 mmHg) and 2.8 ATA (3.94 mmHg) was significant ($p<0.0001$). The mean change in MAP for 2.5 ATA (4.14 mmHg) was not significant when compared to the other treatment pressures.

Summary/Conclusions: This study demonstrated an overall increase in MAP after HBO. Our data indicates a statistically significant increase in MAP for patients undergoing longer treatment for 120 minutes compared to 90 minutes. One would expect the MAP to increase with increasing treatment pressure. Interestingly, the opposite effect was observed in this study with decreased change in MAP at higher treatment pressure. The reasons for this are unclear. The current data suggests shorter treatments at higher pressure may mitigate the overall effect of HBO on MAP.

E 82

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: NO

HYPERBARIC OXYGEN THERAPY FOR OSTOMY PATIENTS: A PILOT CASE STUDY

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Background: Hyperbaric Oxygen Therapy (HBOT) delivers 100% oxygen at a pressure higher than sea level. HBOT is approved for a number of indications such as refractory osteomyelitis, soft tissue radionecrosis, compromised graft/flap, osteoradionecrosis, diabetic lower extremity wounds, decompression sickness, carbon monoxide poisoning and air embolism. Ostomy patients in need of HBOT are often left untreated because of the lack of published data about the safe utilization of this therapy for these patients. In this case series we report the effects of HBOT on 5 ostomy patients.

Case: Sixty-two HBOT patient records were reviewed from 2012 to 2013. Out of these patients 5 had ostomies during HBOT, 3 female and 2 male. They ranged in age from 20 to 72 years. Type of ostomies included colostomy (3), ileostomy (1) and gastrostomy (1) with duration ranging from 1 year to over 30 years. Reasons for ostomies consisted of ovarian cancer (1), colon cancer (2), ulcerative colitis (1) and unknown (1). Adverse effects from ostomies included stoma bleeding (1), painful abdominal gas (1) and skin irritation (1). HBOT pressures ranged from 2.0 to 2.5 atmospheres absolute for 90 minutes duration for 30 to 60 treatments. Diagnoses for HBOT were all unrelated to their ostomies and consisted of compromised graft (2), refractory osteomyelitis (1) and soft tissue radionecrosis (2). Reported adverse effects from HBOT included claustrophobia (1) and ear pain (1), none of which required terminating the HBOT course. Positive effects reported by patients undergoing HBOT were reduction of stoma bleeding (1) and improvement in vision (1). There were zero mortalities related to HBOT.

Conclusions: HBOT was well tolerated by these ostomy patients as indicated by lack of mortalities or serious adverse effects. A larger case series is warranted to further study the relationship between ostomy patients and their tolerance of HBOT.

E 83

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: YES

THE O'NEILL GRADING SYSTEM FOR EVALUATIONOF THE TYMPANIC MEMBRANE / A PRACTICAL APPROACH FOR CLINICAL HYPERBARIC PATIENTS

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Introduction/Background: Eustachian tube dysfunction (ETD) and middle ear barotrauma (MEB) are the two most common complications of clinical hyperbaric oxygen treatment (HBO_2T). The current grading system, Teed’s Classification, described in 1944, is based on a single physician examination of Naval submarine personnel. There have been modifications to this system over the years, but none are specific for the evaluation and treatment of patients undergoing HBO_2T. The majority of patients undergoing HBO_2T are older and may have a number of coexisting medical morbidities. Currently, standard of care is a baseline otoscopic examination performed prior to the start of HBO_2T and is, at times, only repeated for those having difficulty equalizing middle ear pressure during pressurization and depressurization of the chamber. Results from these examinations are used to determine the proper course of treatment. The Teed’s classification does not correlate with the consistency of diagnosis, the clinical approach to relieving symptoms, or the treatment of the inflicted trauma. It is not a practical tool for the modern hyperbaric team. A newer grading system is proposed. The ™ O’Neill Grading system would allow simple and practical use by all members of the clinical hyperbaric medicine team, physicians, nurses, and technologists alike. Grading will be consistent regardless of who performs the otoscopic evaluation. This improvement in the grading system will lead to better outcomes and more consistent methods of intervention and treatment recommendations for the clinical hyperbaric patient. The use of the ™ O’Neill Grading system will maintain consistency when communicating information to hyperbaric centers both nationally and internationally and better correlate potential dysfunction and trauma the clinical hyperbaric patient may be subjected to. Suggestions for appropriate medical interventions to correct or prevent the dysfunction or trauma are considered.

E 84

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: NO

EDUCATING HYPERBARIC STAFF ABOUT COMMON DIABETIC MEDICATIONS AND THEIR POTENTIAL TO INCREASE RISK OF HYPOGLYCEMIA IN DIABETIC PATIENTS UNDERGOING HYPERBARIC OXYGEN TREATMENTS

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Introduction/Background: Staff training and education is crucial to ensuring diabetic patient safety during hyperbaric oxygen treatment (HBOT). It is known that diabetic patients can have a significant drop in blood glucose during HBOT leading to symptomatic hypoglycemia. Each facility has a safety policy to minimize this risk. In practice it was found this risk varied patient to patient even when adhering to policy. Checking levels and feeding patients during treatment is not possible in monoplace chambers. Thus other factors contributing to the patient response were addressed. One area identified was the patient's diabetic medication dosage, particularly insulin, in relationship to the treatment timing. Our hyperbaric staff had differing medical professional backgrounds and exposure to diabetic medications so there needed to be a way to easily increase their knowledge.

Materials and Methods: A single page reference was developed showing onset, peak, and duration of commonly utilized diabetic medications. After introduction to staff, it was used during initial and daily HBOT patient assessment to anticipate increased risk for hypoglycemia due to patient's medication schedule and meals/activity prior to arrival.

Results: Staff increased their knowledge and understanding of diabetic medications. Facility incidence of symptomatic hypoglycemia decreased. Addressing drug and treatment timing proactively helped patients present for treatment with blood glucose levels near to policy, decreasing delays in start times. This also changed some staffs' tendency to give a carbohydrate overload, resulting in undesirable elevated glucose levels post treatment. Many patients also increased their understanding of their diabetic medications and diet/activity interactions.

Summary/Conclusions: Utilizing a diabetic medication reference tool can provide staff with additional knowledge when evaluating hypoglycemia risk in patients with diabetes undergoing HBOT.

E 85

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: NO

THE UTILIZATION OF HYPERBARIC MEDICINE CONSULTATIVE SERVICES: A SURVEY OF ADVOCACY AND POTENTIAL UTILIZATION IN A LARGE, URBAN LEVEL ONE TRAUMA CENTER

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Introduction: HBO_2 therapy is efficacious and cost efficient for a variety of medical and surgical disease processes and injuries. When transferring a HBO_2 consultative service to a new facility, it is important to assess potential utilization and patient volumes.

Methods: A rapid survey was requested by institutional administration to assess the potential volume of an in-patient HBO_2 service. The survey was conducted of the attending physicians present within the clinics, ED, operating theatres and hospital floors over two days. The participants were asked two questions. "How many of these disease processes or injuries do you encounter in a calendar year?" If provided high level of evidence of benefit would you consider a HBO_2 consultation?"

Results: Fifty-one surveys were completed (10% of medical staff). Two surveys were excluded. One was filled out by a resident and another by a CRNA. The remaining surveys provided an estimation of 11,960 potentially referable cases. The vast majority for were hypoxic, traumatic and infectious disease processes. The respondents were fairly evenly distributed, 43% were surgeons (6,349 cases) and 47% were medical specialists (5,521). Overall, 17 medical and surgical specialties and subspecialties were queried. Importantly, 100% of the respondents reported they would refer for HBO_2 consultation for vast majority of their patients. Four attendings indicated they would refer to HBO_2 consultation for certain indications. No attending responded that they would not refer patients to a HBO_2 service.

Conclusions: This survey is preliminary and requires further participation. However, it highlights some important insights not previously considered. First, anesthesiologists appear to be underutilized as a referral source. They reported more cases than any other specialty for 11 indications. Second, internists and subspecialists see far more cases of AVN, osteomyelitis, chronic infections and wounds than previously considered. Moreover, in-person surveying improves knowledge of HBO_2 efficacy.

E 86

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: NO

INDOCYANINE GREEN SCANNING: EMERGING METRICS OF WOUND ANALYSIS AND HYPERBARIC OXYGEN TREATMENT EFFICACY

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Introduction: Fluorescence vascular angiography (FVA) is an angiographic modality engaging the properties of fluorescence dye (indocyanine green) illumined by a near infrared laser light source. This produces an angiographic display of macro and micro-vascular blood flow without introducing ionizing radiation or risking nephrotoxcity. FVA has long been applied intra-operatively to assess perfusion and viability in a wide variety of tissues and clinical conditions. Investigative efforts are underway at several centers examining application of FVA to the discipline of wound healing. At the Institute for Wound Healing and Hyperbaric Medicine (IWCHM) FVA scanning was performed across the full spectrum of complex wounds, with particular focus on patients receiving hyperbaric oxygen treatments and those in the Limb Salvage Program.

Methods: FVA scans were performed both during dedicated clinic hours and during unscheduled patient encounters. The I.V. injections and scanning involved only IWCHM staff. Examinations were performed singly as well as before and after hyperbaric oxygen treatments, before and after ambient pressure oxygen breathing, before and after debridement, and in assessing the effects of specific treatments.

Results: Three hundred and eighty-seven scans were performed on 86 patients during 7 months of FVA use. In 67 patients clinical decisions based on FVA scans positively affected patient outcome. Estimable institutional benefits included compensated patient encounters beyond clinic activities (37%) and referrals from beyond the hospital's historical catchment (21%).

Conclusion: Introducing FVA scanning into an active clinic schedule occurred without logistical difficulties. FVA data analysis produces metrics that: (1) Define specific wound types; (2) Demonstrate the effects of HBOT; (3) Define when HBOT has restored the "Capacity-for-Unaided-Secondary-Healing" (CUSH); and (4) Illustrate the benefits of HBOT in patients who had failed tCOM assessment.

E 87

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: NO

EVOLUTION OF NURSE PRACTITIONERS IN HYPERBARIC MEDICINE

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Introduction/Background: With implementation of the Affordable Care Act, 30 million more Americans may obtain health insurance. This will require the utilization of Nurse Practitioners (NPs) across all practice settings to meet increased need for healthcare services[1]. The Institute of Medicine Future of Nursing Recommendations states that "Advance practice registered nurses should be able to practice to the full extent of their education and training"[2]. According to American Association of Nurse Practice[3], currently 18 states and the District of Columbia allow NPs to have Full Practice Authority (FPA). With hyperbaric/wound clinics on the rise, NPs are a viable option to assure the future of direct patient attendance within the Hyperbaric Medicine setting and to ensure safe, effective delivery of hyperbaric oxygen therapy. The purpose of this review was an attempt to reconcile the pros, cons, discriminations and paradigms concerning the debate over granting nurse practitioners FPA to meet expanding healthcare needs.

Materials/Methods: A systematic query of available literature in the PubMed, CINAHL, and Medline databases was performed using the combined keywords – "nurse practitioner" and "full practice authority".

Results: Data indicated a clear disparity between the level of care that NPs are equipped to deliver and what outdated state practice laws allow them to deliver. Resolving this disparity will serve to reduce some of the difficulties patients encounter when seeking healthcare, such as adequate supervision during hyperbaric oxygen therapy, and increase the safety and efficacy of treatments with improved outcomes.

Summary/Conclusion: These data argue against ideologies that have previously dominated healthcare and are no longer valid. The data further suggests that NPs can safely and effectively help to alleviate pressure on the primary care workforce, including Hyperbaric Medicine. This data further highlighted the need for consistency in each state's scope of practice regulations and its implications for both providers and patients.

E 88

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: NO

LUNG EVALUATION IN PATIENTS ELECTIVELY PLANNED FOR HYPERBARIC OXYGEN THERAPY: IS HRCT NECESSARY IN EVERY PATIENT?

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Introduction: Pulmonary barotrauma is one of the most feared complications of hyperbaric oxygen therapy (HBOT). Pulmonary gas trapping in patients can cause increased risk of barotrauma. Therefore, patients undergoing HBO therapy should be evaluated in terms of the lung lesions but there are different opinions about the appropriate imaging method. In this study, it was investigated how lung evaluation is done in our patients before HBOT.

Material and Methods: The records of patients who were treated with HBOT at the Gulhane Military Medical Academy (GMMA) Department of Underwater and Hyperbaric Medicine, between January 1st, 2013 and December 31st, 2013 were retrospectively evaluated. The patients with suspicious lesions on plain radiographs or those with a history or clinical findings of pulmonary disease were consulted to the Department of Chest Diseases. High resolution computerizes tomography (HRCT) was taken in these patients if deemed necessary by the pulmonologist.

Results : During the study period, 346 patients have been evaluated. Of these, 16 (4.6%) patients were referred to the pulmonologist. Seven of 16 patients were evaluated with HRCT, which revealed pulmonary lesions in 5 patients. These patients were not accepted for HBOT. No incident of pulmonary barotrauma was seen during the study period.

Conclusion: Plain radiographs are usually used to evaluate patients before HBOT. However, plain radiographs are not sensitive enough to show these lesions. HRCT is recommended but it has high radiation and is costly. We think that HRCT is not an appropriate screening test.

E 89

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1630 - 1700
RESIDENT COMPETITION: YES

SNaP® MECHANICALLY POWERED NEGATIVE PRESSURE WOUND THERAPY SYSTEM HYPERBARIC CHAMBER COMPATIBILITY ASSESSMENT

Stabile J, Weaver LK, Moffat A, Medford MA, Bell J
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Introduction/Background: The SNaP® Wound Care System(Spiracur Inc., Sunnyvale, CA) is a mechanically powered negative pressure wound therapy device. The FDA cleared this device in 2009; Spiracur instructions for use require removal of the suction canister during hyperbaric oxygen (HBO_2). Safety and compatibility of the SNaP® during HBO_2 exist and warrant evaluation.

Materials/Methods: A safety review was completed. A Sechrist© (Sechrist Industries, Inc., Anaheim, CA) monoplace chamber was utilized to pressurize the SNaP® 125mmHg, 100mmHg and 75mmHg devices. We utilized a Nurturing Wounds simulation limb for this evaluation. Chamber pressures were 2.0, 2.4, and 3.0 ATA. A 760-0 mmHgA pressure gauge(model DPG10008760MMHGA-5)(Cecomp Electronics, Libertyville, IL) was used to monitor the suction provided by the SNaP® device during hyperbaric exposure.

Results: We found no concerns for implosion, explosion, heat or sparking. At ≥2.0 ATA the foam contracted into the simulated wound bed and the plunger remained completely depressed (from starting at 10ml). It remained there until returning to ambient pressure (0.85 ATA) where it was 20ml. The device maintained this volume demonstrating preserved seal and functionality.

	SNaP® Vacuum Pressure(mmHg) (SNaP® 125mmHg)	SNaP® Vacuum Pressure(mmHg) (SNaP® 100mmHg)	SNaP® Vacuum Pressure(mmHg) (SNaP® 75mmHg)
0.85 ATA 0.0psig 12.4psia	-135	-106	-85
2.0 ATA 17psig 29.4psia	-77	-42	-14
2.4 ATA 22.9psig 35.3psia	-59	-23	+7
3.0 ATA 31.7psig 44.1psia	-33	+5	+34

Summary/Conclusion: Our limited experience indicates that the SNaP® Wound Care devices perform appropriately during HBO_2 and maintained functionality after testing. The SNaP® 75mmHg device was unable to maintain negative pressure on the wound at 2.4 and 3.0 ATA and 100mmHg device at 3.0 ATA. Individual patient requirements for mechanically powered negative pressure therapy and specific HBO_2 needs should be considered. Lacking electrical or overtly hazardous components it is reasonable to allow patients to maintain uninterrupted, negative pressure therapy with all SNaP® devices to 2.0 ATA during HBO_2.

E 90

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: WITHDREW
RESIDENT COMPETITION:

TRANSCUTANEOUS CARBON DIOXIDE AND END TIDAL CARBON DIOXIDE MONITORING IN A 2 YEAR-OLD CARBON MONOXIDE PATIENT

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WITHDREW

E 91

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: NO

VENTILATOR TESTING IN A MULTIPLACE HYPERBARIC CHAMBER

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Introduction/Background: Due to the limited marketplace, medical device companies generally do not make devices specifically for use in hyperbaric environments. This results in clinicians needing to modify medical devices or simply not use them. The use of medical devices under barometric pressure that are safe, accurate, and cost effective could help increase positive patient outcome. The Atlantis BaroVent is a FDA approved hyperbaric ventilator. Mechanical testing of the ventilator's capabilities under hyperbaric conditions was conducted.

Material and Methods: The Atlantis BaroVent and Michigan Instruments, Inc. 4600 Model single-testing-lung were set up in a multiplace hyperbaric chamber. Three trials were conducted; for each trial, ventilator was set per standards. Inspiratory time was set at 1.0, spontaneous breath rate at 10 breaths per minute, and tidal volume varied per trial to 300ml, 500ml, and 800ml. Measurements were taken every 30 seconds for 10 minutes at three stages: sea level, compressing to 33FSW, and stabilized 33FSW. A penetrator was built to connect the test lung USB port inside the chamber to the workstation outside the chamber. The testing lung PneuView computer program recorded the tidal volume (±20 mL), inspiratory time (±0.03 sec), and spontaneous breath rate (±1 bpm) at every 30 second mark.

Results:

	Initial Parameter	Average Sea-Level	Average 33FSW	Percent change from Sea-Level
		(N=20)	(N=19)	
Tidal Volume(mL)	300	235.95	167.211	29.13% decrease
Inspiratory Time(s)	1	1.1755	1.01526	13.63% decrease
Spontaneous Breath Rate(breath/minute)	10	9.642	11.8363	22.76% increase
		(N=20)	(N=19)	
Tidal Volume(mL)	500	406.2	265.368	34.67% decrease
Inspiratory Time(s)	1	1.172	1.01211	13.64% decrease
Spontaneous Breath Rate(breath/minute)	10	9.4875	11.6953	23.27% increase
		(N=20)	(N=20)	
Tidal Volume(mL)	800	671	405.7	39.54% decrease
Inspiratory Time(s)	1	1.1505	1.008	12.39% decrease
Spontaneous Breath Rate(breath/minute)	10	9.8875	11.807	19.41% increase

Conclusion: The ventilator did not effectively compensate for increasing pressure when diving.

E 92

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: NO

PATIENT GROUNDING VALIDATION IN MONOPLACE CHAMBERS

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Introduction/Background: The National Fire Protection Association (NFPA) 99 requires patients be electrically grounded via high impedance conductive pathway when the hyperbaric chamber atmosphere exceeds 23.5% O_2. Both NFPA 77 (2014 edition) and the Sechrist manual recommend an encircling wrist strap, but NFPA 77 (1.4) allows for equivalent or superior systems, methods or devices, to be determined by the safety director (NFPA 99). Though we have routinely grounded our patients treated in monoplace hyperbaric chambers with electrode patches for two decades, we initiated ground checks to validate this practice.

Materials/Methods: We routinely place an electrode patch (Kendall 850 foam electrode P/N# 22850) connected to a grounding strap (Desco P/N# 09680) on the patient before every monoplace hyperbaric session. During the study period, we verified patient ground pre-and post-treatment using the Sechrist patient and chamber ground test kit (PN#20501-1) and recorded this data on a grounding check sheet.

Results: From 2/21/2013 to 12/31/2013 (739 monoplace treatments), we recorded patient grounding verification before treatment for 478 sessions (64%) and after treatment for 440 sessions (60%). We identified four instances of ground failure at the conclusion of the chamber session (1%): the grounding strap was replaced in one instance, and in another, the chart noted that the patient had perspired heavily during the session. For the other two patients, no further data is available.

Summary/Conclusions: It took a number of months to achieve good documentation compliance. We identified a 1% ground failure rate and encourage monoplace chamber manufacturers to develop technology that will notify the chamber operator of ground failure so that ground can be re-established or the chamber decompressed. We plan to continue to use the electrode patch for grounding, as it is has no known safety risk and is preferred by staff (infection control, convenience) and patients (comfort).

E 93

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: NO

EVALUATION OF THE NOVA BIOMEDICAL STATSTRIP GLUCOSE XPRESS FOR USE IN THE MULTIPLACE CHAMBER

Bell JE, Deru K, Koumandakis G, Weaver LK
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Introduction/Background: Our institutions have approved the Nova Biomedical StatStrip glucose meter (#44993) for point-of-care testing. The StatStrip uses a rechargeable lithium ion battery (Lithium-polymer battery #AS2001), and NFPA 99 14.2.7.3.17.5 prohibits lithium/lithium-ion batteries in the chamber. To obtain a glucose measurement from a patient during chamber compression, we lock out a blood sample using a Drummond Scientific pipet (#7-000-0650-LHC). The StatStrip Xpress glucose meter (#43404) uses a non-rechargeable lithium manganese oxide battery (Duracell DL2450, 3V lithium manganese oxide), and risks associated with this battery include ingestion, crushing, overheating and short circuiting. We evaluated the Xpress meter for safety and accuracy for in-chamber glucose testing.

Materials/Methods: We performed a risk assessment on the StatStrip Xpress and an unmanned pressurization (nitrogen) to 90 psig (battery in the device). We also compared the accuracy of the StatStrip at ambient pressure (0.85 ATA) against two Xpress meters (0.85, 2.0, and 3.0 ATA) using a precision linearity kit (Nova Biomedical #42173) in the Fink DL-8 multiplace chamber.

Results: The pressure testing did not damage the device or the battery. Because this battery is contained within the device, not recharged, and not exposed to heat, we permitted it inside the multiplace chamber. Using the precision testing kit, all ambient pressure measurements were in range (n=30 for each meter). At 3.0 ATA, one Xpress meter reading fell out of range at the 500 mg/dl level, while all other glucose measurements at 2.0 and 3.0 ATA were in range (n=30 for each meter).

Summary/Conclusions: We have approved the Xpress glucose meter (#43404) for in-chamber glucose screening. We do not recommend in-chamber use of the Statstrip (#44993) as it uses the rechargeable lithium-polymer battery. Definitive glucose levels, such as for insulin dosing, will require laboratory/blood gas testing. Meter accuracy should be validated using a well-controlled blood study.

E 94

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: NO

INCIDENCE OF MIDDLE-EAR BAROTRAUMA WITH HYPERBARIC OXYGEN THERAPY

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Introduction: Middle-ear barotrauma is a known risk from hyperbaric oxygen therapy (HBO_2), but the range of reported incidence is large (2% to 45%). We performed a retrospective review of patients receiving HBO_2 to determine the incidence of middle-ear barotrauma at our facilities.

Methods: We reviewed charts of patients initiating HBO_2 1/1/2011-12/31/2013 at two hospital-based hyperbaric centers (Intermountain Medical Center and LDS Hospital). Our staff inspected tympanic membranes (TM) by otoscope before and after each HBO_2 session and graded middle-ear barotrauma per the modified TEED scale.

Results: 330 were patients treated during the review interval, and 302 had TEED data recorded (181 (40%) male, mean age 49±20 years (range 1-92), mean sessions 15±17 (range 1-76), 24 intubated). 138 patients (46%) experienced middle-ear barotrauma after at least one HBO_2 session. Four patients had tympanostomy tubes placed to facilitate continued HBO_2, and 5 received decongestants. 22/24 intubated patients (92%) experienced middle-ear barotrauma, including the 10 patients with TEED-4. Of non-intubated patients, 71/157 patients (45%) treated exclusively in monoplace chambers, and 14/47 (30%) treated exclusively in the multiplace chamber, experienced middle-ear barotrauma.

	After HBO_2 #1	After HBO_2 #2	After HBO_2 #3	During HBO_2 Course
Patients	285	266	249	302
TEED-0	205 (72%)	192 (72%)	183 (73%)	164 (54%)
TEED-1	41 (14%)	26 (10%)	23 (9%)	107 (35%)
TEED-2	21 (7%)	22 (8%)	22 (9%)	60 (20%)
TEED-3	9 (3%)	13 (5%)	10 (4%)	21 (7%)
TEED-4	2 (1%)	7 (3%)	5 (2%)	10 (3%)
TEED-5	0 (0%)			
Wax	7 (2%)	6 (2%)	6 (2%)	14 (5%)

Conclusions: Though 46% of our patients experienced middle-ear barotrauma, only 4 patients (1% of total) required tympanostomy tubes to continue their HBO_2 course; therefore, the clinical significance of this barotrauma is unknown. Decongestants were rarely offered due to concerns about vasoconstriction.

E 95

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: NO

ALCOHOL-IMPREGNATED PORT PROTECTORS: A NEW POTENTIAL RISK FOR HYPERBARIC CHAMBERS

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Background: Alcohol-impregnated port protectors on peripheral and central venous catheter hubs are being increasingly used to reduce nosocomial bloodstream infections. These contain isopropyl alcohol, prohibited in class B chambers and very restricted in class A chambers by NFPA guidelines due to risk of fire.

Materials and Methods: A literature review and web search was conducted as to the benefits, risks, and uses for alcohol impregnated port protectors.

Results: Line hub contamination is a risk factor for the development of bloodstream infections. In 2006, Menyhay reported that conventional disinfection of contaminated hubs with 70% alcohol swabs did not prevent entry of microorganisms as well as alcohol-impregnated port protectors. In 2013 Sweet showed a significant reduction in catheter-associated bloodstream infections using these devices.

Four brands of alcohol-impregnated port protectors are currently sold in the United States. "SwabCap" by Excelsior Medical (orange Leur lock cap), "Curos",by Ivera Medical Corporation (white cap for dialysis catheters, and green for all other lines), "DualCap" by Catheter Connections (blue caps for both female and male ports), and "LifeShield EffectIV Cap" (clear white caps) by Hospira. These single use caps contain a sponge impregnated with 70% isopropyl alcohol that disinfects the port within 3-5 minutes and, if left in place, provides a barrier to contamination for 4-7 days.

Conclusion: There is a rapid increase in use of alcohol-impregnated venous port protectors for both inpatient and outpatient catheters but we have also found them on devices such as urinary catheter access ports. At our institution, we have placed cautionary signage at patient assessment stations and check for these devices during the safety "time out". We recommend instituting protocols to insure that they do not enter the hyperbaric environment.

E 96

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: NO

QUANTITATIVE EVALUATION FOR EFFECTS OF HYPERBARIC OXYGEN TREATMENT ON PATIENTS WITH ANKLE SPRAIN AT AN ACUTE PHASE

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Introduction: Ankle sprain is a major soft tissue injury during sports activity, which causes localized edema and pain at an acute phase, and sometimes involves joint capsule and/or ligamentous injuries. HBO involves the effect of edema reduction and improvement from injured tissue hypoxia, and it is expected that HBO can accelerate reduction of subjective pain, and promote the healing processes of injured tissues. The purpose of this study was to identify the effects of HBO on reduction edema and pain in patients with ankle sprain at an acute phase.

Patients and Methods: Twenty patients with acute ankle sprains that occurred during sports activity between 2007 and 2012, who visited our clinic within 7 days after the injury, were investigated in this study. The HBO application was performed with 2.5 ATA for 60 minutes from once to 5 times. The ankle volume evaluated with water-filled volumetric gauge, and visual analog scales (VASs), which question included pain at rest, pain while walking, and subjective evaluation for edema, were evaluated just before and after HBO.

Results: Ankle volume was significantly reduced and the volume reduction reached 15cm^3 ($p<0.001$), including edema reduction of 18 cm^3 at the 1st HBO, 14 cm^3 at the 2nd HBO, 16 cm^3 at the 3rd HBO, 5 cm^3 at the 4th HBO, and 6 cm^3 at the 5th HBO. VAS scores at before and after HBO regarding pain while walking were respectively 41.7 and 30.3 points ($p<0.001$), and those regarding subjective evaluation of edema were respectively 48.0 and 42.2 points ($p<0.01$). VAS scores regarding pain while walking depending on HBO times were respectively 67.1 and 48.1 at the 1st HBO, and 34.6 and 28.1 at the 2nd HBO.

Conclusions: HBO was effective for reducing ankle edema and pain in patients with ankle sprains at an acute phase.

E 97

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: NO

ANALYSIS OF EMMA END TIDAL CO2 UNDER INCREASE BAROMETRIC PRESSURE

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Introduction/Background: End tidal CO_2 ($EtCO_2$) is used in emergency and intensive care settings and has become widely used when evaluating pulmonary ventilation in intubated patients. Transcutaneous carbon dioxide pressure ($TcPCO_2$) evaluates pulmonary ventilation in intubated patients. The Emergency Capnometer EMMA™ ($PETCO_2$) is a small transportable device that measures EtCO2. We compared $PETCO_2$ against $TcPCO_2$ under increased pressure.

Methods: A Radiometer America, TCM TOSCA monitor was set to 43°C, tc sensor 92 was placed over the left second intercostal space. One healthy 29 y.o. male participated. A tight-fitting bird mask was secured to the subject's face. Intake and exhaust ports of the mask were one-way valves which allowed exhaled gas to move out in one singular direction. EMMA™ $PETCO_2$ (±0.3kPa/±2mmHg) was secured to the 22mm diameter exhaust port of the mask. Subject lay supine during measurements. A warm-up period of 10 minutes was completed before data collection. Samples were collected simultaneously from each device every minute. Data was sampled at 33, 40, 66, and 100 FSW.

Results: Mean CO_2 values of the $TcPCO_2$ and the $PETCO_2$ were compared at varying barometric pressures. Means were tested for differences using a paired samples *t*-test and the difference for measured CO_2 levels was significant at 33, 40, 66, and 100 FSW. Means were not significantly different when compared at sea level, $t(39) = -1.483$, $p < 0.001$.

Depth (FSW)	*t*	df	*p*
33	-6.089	35	< 0.001
40	5.177	13	< 0.001
66	18.419	10	< 0.001
100	38.48	8	< 0.001

Conclusion

The $PETCO_2$ did not effectively compensate under increased barometric pressure when compared to $TcPCO_2$. Further research is required to generate measurement equivalencies between the $PETCO_2$ and the TcPCO2 when used under increased barometric pressures.

E 98

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: YES

CAPNOGRAPH TESTING AND COMPARISON AT TREATMENT PRESSURE WITHIN THE MULTIPLACE

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There are a few multiplace facilities that monitor carbon dioxide levels exhaled from a ventilated patient. The current method used to send the patient's exhaled ETCO2 out of the chamber is technical and can be expensive. The Masimo "Emma" capnograph entered the market in July, 2013. Emma offers a small, lightweight, and inexpensive effective means of monitoring a patient's ETCO2. Although it is not intended nor designed for hyperbaric use, its compact design and use of alkaline batteries offers in chamber possibilities. We decided to test the Emma at various pressures within our multiplace to determine feasibility of using this equipment in the hyperbaric setting.

We currently use the Univent Eagle portable ventilation unit for ventilation of sedated intensive care patients during a multiplace hyperbaric treatment. Our ventilator performs satisfactorily, and patient baseline tidal volume delivery is confirmed by utilizing a wright inspirometer. However, ETCO2 has been deemed the most effective means of confirming adequate patient ventilation. We currently have no means of monitoring the patient's ETCO2 levels.

Additional benefits include:

- Provide similar standard of care related to ventilatory lab monitoring provided in our ICU and hyperbaric chamber.
- Provide additional information to help Respiratory Therapists assess patients' ventilatory status while managing intubated patients influenced by hyperbaric gas laws.
- Assist RT with diagnosis of nuances of the Impact 754 ventilator under hyperbaric conditions and the potential inaccuracy of the delivered volume readout on the ventilator.

Testing protocol:

Using EMMA we established and validated a 1 ATA baseline CO2 readings using a regulated gas flow configuration from the following certified CO2 supply mixtures: 3%, 5%, 6%. We duplicated this process at 2.0 & 3.0 ATA within the multiplace chamber and compared the readings. Gas flows were monitored with analog regulators, on the gas supplies, as well as by wright inspirometers on the gas loop during the charging phase to the EMMA capnograph during testing at each atmospheric pressure including normobaric.

E 99

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: YES

HOOKED ON HOOKAH: SEVERE CARBON MONOXIDE POISONING IN WATER-PIPE USERS

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Introduction/Background: The water pipe (hookah) as a method of smoking tobacco and other substances is gaining popularity both in the US and worldwide. In the past 5 years there have been numerous reports of serious carbon monoxide (CO) poisoning after smoking hookah. A possible cause of increased incidence is the use of 'quick-light' coals. In this study we report the case of a 40 year hookah smoker who presented to our hospital following first time use of quick-light coals. We performed a comparative study under laboratory conditions of natural wood versus quick-light charcoal and CO production. We found that quick-light coal produces significantly higher levels of CO than natural wood coal during a typical smoking session.

Materials and Methods: A medium sized hookah was assembled with the water-pipe hose attached to an activated charcoal filter. A single 11 gram tablet of either natural wood or quick-light charcoal was placed atop an 18-hole perforated aluminum foil barrier and ignited. A 3 liter calibrated syringe was used to withdraw 600 mL of smoke from the hookah apparatus, diluted with 2.4 liters of air and equilibrated in a 3 liter dilution bag, the contents of which were analyzed by a calibrated CO-meter (Bacharach 0-2000 ppm). Samples were drawn every 3 minutes during a total run time of 90 minutes. Coal core temperatures were measured (^{o}C) every 3 minutes using a laser thermometer. All measurements were done in triplicate and group data were analyzed by two-way repeated measures ANOVA using a p-value less than 0.05 as statistically significant.

Results:

Mean CO (ppm)		
Time (minutes)	Quick-light*	Natural Wood
0	0.0	0.0
15	5847.5	2212.5
30	6885	2060
45	4217.5	1982.5
60	2467.5	1490.0
75	1540.0	1132.5
90	987.5	930.0

Mean Temp (^{o}C)		
Time (minutes)	Quick-light**	Natural Wood
0	424	483
15	364	412
30	287	347
45	235	286
60	202	233
75	148	203
90	95	167

* $p < 0.0001$, ** $p < 0.05$

Summary/Conclusions: Quick-light charcoal produces significantly more carbon monoxide than natural wood charcoal over a 90 minute smoking period. The ease of use and availability of quick-light coals may in part contribute to the increased incidence and severity of carbon monoxide poisoning in hookah smokers.

E 116

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1130 - 1200
RESIDENT COMPETITION: YES

HBO IN RADIATION-INDUCED CYSTITIS AND PROCTITIS: TWO-YEAR FOLLOW-UP OF A PROSPECTIVE COHORT STUDY ON PATIENT-PERCEIVED QUALITY OF RECOVERY

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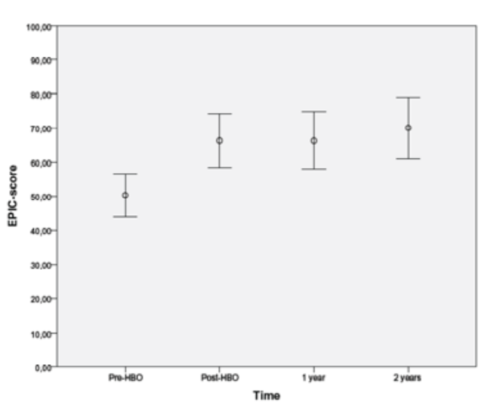
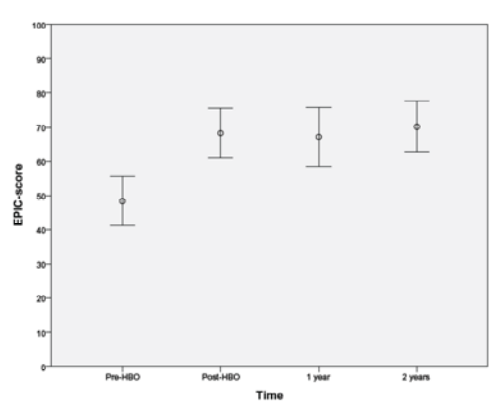
Purpose: Evaluation of the long term effect of hyperbaric oxygen treatment (HBOT) concerning patient-perceived symptoms of late radiation-induced cystitis and proctitis secondary to radiation therapy for pelvic cancer.

Methods and Materials: Thirty-nine patients, 35 men and 4 women with a mean age of 71 (range 35-84) were included in the original study. They had all been treated with radiation therapy for prostate (n=34), cervix (n=2) or rectal (n=3) cancer using external beam radiation at a dose of 25 to 75 Gy. Patients with hematuria requiring blood transfusion were excluded. The HBOT was delivered with 100% oxygen for 90 minutes at 2.0 to 2.4 atmospheres (ATA). Mean number of treatments was 36 (28-40). Symptoms were prospectively assessed using the Expanded Prostate Index Composite score (EPIC) before, during and 6 to 12 months after HBOT. EPIC was also used to evaluate the long-term effect two years after HBOT.

Results: The original symptom reduction, demonstrated by an increase in EPIC score, was sustained at the two-year follow-up. Seven patients were lost to follow-up. Five patients had deceased of causes not related to HBOT and two were unreachable. Five patients deteriorated to such a degree that they required surgical intervention with stoma (n=3) and/or urinal deviation (n=3). The mean EPIC score for the bowel domain before HBOT was 27 for the three patients that subsequently needed a stoma, indicating that they had severe symptoms even before HBOT. The same trend was not seen in the group requiring urinal deviation. In the original study HBOT was successfully conducted, and symptoms were alleviated in 76% for patients with radiation cystitis, 89% for patients with radiation proctitis, and 88% of patients with combined cystitis and proctitis. Symptom reduction was demonstrated by an increased EPIC score in the urinary domain from 50 +/- 16 to 66 +/-20 after treatment (P<.001) and in the bowel domain from 48 +/- 18 to 68 +/- 18 after treatment (P<.001). For 31% of the patients with cystitis and 22% with proctitis, there were only trivial symptoms after HBOT. No severe side effects were observed related to HBOT, and treatment compliance was high.

Conclusions: Patient perceived symptom reduction after HBOT for late radiation therapy induced soft tissue injuries in the pelvic region is sustained for the majority of patients even two years after treatment.





PLENARY: *New Pearls of Wisdom in the Diving and Hyperbaric Medicine Literature*

Marlon Medford, MD & Manish Mehta, MD

1330 - 1430

About the Lecturers:

Marlon Medford, MD

NATIONALITY:	Trinidad and Tobago
DATE OF BIRTH:	20 March 1980
MARITAL STATUS:	Married to Marta Jarosińska - Nationality: Polish
LANGUAGES:	English (native), Spanish (Latin American)

EDUCATION

2014-2016	Fellowship – Critical Care Medicine, Jackson Memorial Hospital, University of Miami Miller School of Medicine, Miami, FL.
2013-2014:	Clinical Fellowship - Hyperbaric and Undersea Medicine, Duke University Hospital, Durham, NC.
2012-2013:	Research Fellowship – Pulmonology, Duke University Hospital, Durham, NC. 2010-2012: Residency - Internal Medicine, State University of New York-Downstate, NY
2009-2010:	Internship – Medicine, State University of New York-Downstate, NY
2004-2005:	Internship - Medicine, General Surgery, Pediatrics, Ob.Gyn., San Fernando General Hospital. Trinidad and Tobago
03-05/2003	Research Scholar - Molecular Neurosurgery, Harvard Medical School, Boston, MA
1999-2004	M.B.B.S. (M.D.) Bachelor of Medicine, Bachelor of Surgery, University of the West Indies. Trinidad and Tobago
1991-1999	Presentation College, San Fernando. Trinidad and Tobago

Manish Mehta, MD

Dr Manish Mehta was born to physician parents in India's most modern and planned city of Chandigarh - where he also obtained his medical degree at the prestigious Government Medical College. He went on to complete a Diagnostic Radiology residency in India before migrating to the US in 2009. He completed an Internal Medicine Residency at Santa Barbara Cottage Hospital later achieving his board certification. Currently he is in the Undersea and Hyperbaric Medicine fellowship program at UC San Diego and lives in Murrieta CA with his wife and two sons where he also works part time as a hospitalist. His long-term clinical interests include chronic wound healing, hyperbaric medicine and research into its newer indications, vascular medicine and limb salvage. He enjoys reading about latest technology and automobiles and spending time with his family. He aspires to be a physician entrepreneur in the future

About the Lecture:
New Pearls of Wisdom in the Diving and Hyperbaric Medicine Literature

We will be reviewing the most up to date articles and discussing new pearls of wisdom in the diving and hyperbaric medicine literature that every treating provider should know. We will be covering topics such as carbon monoxide poisoning, traumatic brain injury, and the latest and greatest regarding decompression sickness.

SESSION F
Diving Equipment and Decompression Illness

F 100

ORAL PRESENTATION TIME: 1442 - 1454
POSTER PRESENTATION TIME: 1630 - 1700
RESIDENT COMPETITION: NO

THE SIGNIFICANCE OF NOISE EXPOSURE OF DIVERS DURING TYPICAL DIVING OPERATIONS IN THE NORWEGIAN SECTOR OF THE NORTH SEA

Nedwell JR, Mason TI, Collett AG, Gardiner RWK
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The objective of the study was to quantify and evaluate the noise exposure of divers in a demand helmet in typical conditions in the Norwegian sector of the North Sea by providing and interpreting actual measurements of the noise, and evaluating their significance by reference to existing guidelines for noise exposure. The weight of evidence is that the hearing of divers in hyperbaric gas exhibits significantly different sensitivity and frequency behaviour compared with that in air at atmospheric pressure. Consequently, a very important part of the study was to develop a robust and defensible method of allowing for the changed sensitivity of the human ear during exposure to noise in the hyperbaric environment.

Measurements were made at the ear of the diver and outside the helmet in the water during routine diving operations using a purpose-designed hyperbaric recording system. It was found that the greatest contributors to the noise exposure of the divers during the three offshore surveys investigated were the flow noise produced when the diver breathed, and noise from communications. The measurements were first corrected in level and frequency for hyperbaric effects using the change in hearing threshold in hyperbaric gas reported by Mendel et al (2000). The significance of the noise levels recorded was then assessed against a conventional criterion of a maximum safe level being equivalent to a continuous exposure of 85 dB(A) re 20 µPa. It was found that nearly all the time-averaged sound pressure levels measured inside diver's helmets, even when corrected for hyperbaric exposure and excluding noise exposure during non-dive periods, exceed the noise exposure criterion.

F 101

ORAL PRESENTATION TIME: 1454 - 1506
POSTER PRESENTATION TIME: 1630 - 1700
RESIDENT COMPETITION: NO

DIVING INTO THE HEART OF TROUBLE: CARDIAC HEALTH OF UK SPORT DIVERS

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Background: Divers can be reluctant to acknowledge health problems, and self-certification may not be a reliable indicator of health. Recent British incident data shows increasing diving fatalities in the over 50 year age group. Two recent studies revealed 9% and 10% of respondent (current) divers took cardiac medications for primary or secondary disease prevention, and/or symptomatic cardiac disease. The compulsion to undergo diving medicals/self-certification in the UK is limited.

Methods: An anonymous on-line survey was publicised through diving exhibitions and social media. Measures included diver and diving demographics, physician prescribed medications, diagnosed hypertension, other health issues and medications, year of last diving medical, diagnosed patent foramen ovale (PFO), smoking and alcohol habits, exercise, and BMI.

Results: A total of 672 records (76% male and 24% female; mean age 44; age range 12 to 78) fulfilled the inclusion criteria. Respondents with no diving medical numbered 183 (27%), and a further 72 (11%) had not undertaken a medical for more than 10 years. High blood pressure was reported by 119 (18%), with 21% of that group having no diving medical. Heart attacks (6), coronary artery bypass grafting (3), atrial fibrillation (19) and angina (12), were reported by respondents since learning to dive. A total of 28 PFOs were reported, with 20 opting for a closure procedure. Of the 83 treated incidences of decompression illness (DCI), 19 divers had a PFO.

Conclusions: As divers continue through their diving career, some inevitably develop health problems and continue to dive. Considerable numbers of divers have cardiac issues but do not undergo a diving medical. The treatment of diving related illnesses under the UK National Health Service (free at point of care) may contribute in part to the lack of rigorous health surveillance or accurate self-assessment in UK divers.

F 102

ORAL PRESENTATION TIME: 1506 - 1518
POSTER PRESENTATION TIME: 1630 - 1700
RESIDENT COMPETITION: YES

UNRECOGNIZED DECOMPRESSION SICKNESS AMONG BREATH-HOLDING PEARL DIVERS IN THE ARABIAN GULF

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Background: Prior to the development of the Japanese cultured pearling industry in the 1930s, pearl fishing throughout the Arabian Peninsula was a major enterprise. The labor-force behind the industry included many who were in various forms of economic servitude and in some instances even slavery, harvesting oysters from boats throughout the Arabian Gulf from the 650km of coast-line which now geographically constitute the United Arab Emirates and its neighboring countries.

They retrieved pearls by making repeated breath-hold dives to depths of up to 30 meters, with surface intervals of a couple of minutes or less, for 12-14 hours each day. Longer surface intervals were infrequent, for the purposes of prayers or meals only. We hypothesize that these repeated breath-hold dives often resulted in unrecognized cases of decompression sickness. In anecdotal accounts, these pearl divers describe an array of neurological symptoms that would now be consistent with this diagnosis. This would correlate with the syndrome of Taravana found among breath-hold divers in the Tuamoto Archipelago in the South Pacific - a condition that is now widely recognized to be caused by decompression sickness as described in several papers by Craig, Lanphier and Paulev.

Methods: Through review of historical accounts of the pearlers' diving patterns, including first-hand interviews, the characteristics of their dive profiles including depth, bottom time, surface interval time and breaks in the day were identified. These data were then incorporated into a freely-available dive planning package which implements the previously-tested AB-2 decompression algorithm. Decompression ceilings were calculated for these dive profiles, and breaches of those ceilings were identified.

Results: Several of the repetitive breath-hold dive profiles create unavoidable ceiling violations from which decompression sickness would be a plausible consequence.

Conclusion: Pearl divers in the Arabian Peninsula were unwittingly and routinely subjected to decompression sickness as an occupational hazard.

F 103

ORAL PRESENTATION TIME: 1518 - 1530
POSTER PRESENTATION TIME: 1630 - 1700
RESIDENT COMPETITION: NO

CO AND CO2 ANALYSIS IN THE DIVING GAS OF THE FISHERMEN OF THE YUCATAN PENINSULA

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Introduction/Background: More than 75% of 300 harvest fishermen of the Yucatan Peninsula experience decompression illness (DCI) annually, making DCI an epidemic in this region. Fishermen utilize primitive hookah systems supplied by poorly-filtered gas compressors. As a result, carbon monoxide (CO) and carbon dioxide (CO_2) are compressed into their air supply. Our suspicion is that these fishermen are also being poisoned by CO and CO_2. Exposure to excessive amounts of CO and CO2 can lead to symptoms similar to DCI. Distinguishing source of injury could lead to specifically targeted interventions.

Materials and Methods: 10 fishermen (Avg. Age: 38, Avg. BMI: 33) from a single fishing cohort agreed to participate in an observational study approved by the UCLA IRB. Fishermen were instructed not to drain their volume tanks following their last dive of the day before gas samples were obtained. The hookah system utilized in this region consists of a gas engine (5-6.5 HP), single stage compressor, and a volume tank of 2.0 cubic feet. Dräger® CO 2/a Short-term Tubes (± 10%) and Dräger® CO_2 100/a Short-term tubes (± 10%) were used to measure 1.0 L gas samples through a Visi-Float® flowmeter (±5%) at 0.2 L/min for 5 minutes.

Results:

Air-Supply Contaminant	Mean (ppm)	Range (ppm)	Median (ppm)
CO (N = 10)	42	8-150	30
CO_2 (N = 10)	663	600-800	600

Summary/Conclusions: CO and CO_2 measurements exceeded recommended diving norms (CO 10 ppm; CO_2 500 ppm). Gas filtration is needed to reduce the risk of both CO and CO_2 poisoning. Ambiguous symptomology among DCI, CO poisoning, and CO_2 poisoning in this population makes distinguishing injury difficult. Eliminating confounding variables will enable the implementation of interventions aimed at decreasing the risk of DCI.

F 104

ORAL PRESENTATION TIME: 1530 - 1542
POSTER PRESENTATION TIME: 1630 - 1700
RESIDENT COMPETITION: NO

MODELING CARBON MONOXIDE REDUCTION IN A SINGLE COMPRESSOR HOOKAH DIVE SYSTEM

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Introduction/Background: Diving and governmental organizations have established safety standards for carbon monoxide (CO) content in a diver's air supply. Hookah dive systems (HDS) are used globally by recreational divers and harvest fishermen; however, many lack modifications that produce safe human air sources. By quantifying the levels of CO in the air supply generated by a model HDS we aimed to determine if separation of gas engine exhaust from compressor intake could produce CO levels within the range of existing safety standards.

Materials and methods: A model HDS was constructed using a Hitachi® EC2510E 1ft^3 Gas Horizontal Air Compressor powered by 5.5HP engine and delivering 145 PSI of gas pressure. The compressor and engine idled for 20 minutes prior to acquisition of gas measurements. Gas samples were obtained every 30 seconds from a .25", 4ft Swagelok® Special Tubing Natural hose connected to the volume tank via a quick-disconnect. Samples were analyzed by a C-Squared® Carbon Monoxide Analyzer (±1ppm) through a Visi-Float® flowmeter (±5%) at 0.2L/min. Baseline gas measurements from the HDS were acquired first. Next, gas measurements were obtained after a 5ft Watts® 1-1/4 polyethylene hose with an attached large-particle filter was connected to the compressor intake and elevated 5ft above the engine exhaust.

Results: Mean CO values were tested for differences using a paired samples *t*-test and the difference was significant, $t(46) = 9.720$, $p < 0.001$

	Pre-Intervention			**Post-Intervention**		
Air-Supply	**N = 47**			**N = 47**		
Contaminant	*Mean (ppm)*	*Range (ppm)*	*SD*	*Mean (ppm)*	*Range (ppm)*	*SD*
CO	21.93	9-54	9.60	6.8	4-14	2.4

Summary/Conclusions: The physical separation of the gas engine exhaust from the compressor intake reduced CO in the volume tank. This cost-effective intervention can easily be implemented to any Hookah Diving System.

F 105

ORAL PRESENTATION TIME: 1542 - 1554
POSTER PRESENTATION TIME: 1630 - 1700
RESIDENT COMPETITION: NO

REDUCING CARBON MONOXIDE CONTENT IN SURFACE-SUPPLIED (HOOKAH) AIR SOURCES OF ARTISANAL FISHERMEN OF THE YUCATAN PENINSULA

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Introduction/Background: Fishermen in the Yucatan Peninsula utilize primitive hookah systems supplied by poorly-filtered gas compressors. Gas engine exhaust is located in close proximity to air compressor intake which allows carbon monoxide (CO) and carbon dioxide (CO_2) to directly enter the volume tank air supply. Conservative safety standards permit a diver's air supply to contain 10 ppm of CO and 500 ppm of CO_2. This study quantified the levels of CO and CO_2 from the fishermen's air supply both before and after physical separation of engine exhaust from compressor intake.

Materials & Methods: Volume tanks were analyzed for CO and CO_2 both before and after a 1" hose was attached to the compressor intake and elevated 5 feet above gas engine exhaust. Tanks were drained and refilled before post-intervention measurements. A C-Squared® CO Analyzer (±1 ppm) calibrated with a Praxair 70 ppmv CO-N_2 gas (±5%) and an Analox® Aspida CO_2 Analyzer (±1%) were used to analyze gas samples. 4 CO and 4 CO_2 values per each of the seven volume tanks analyzed were collected before and after the intervention.

Results: Mean CO and CO_2 values were compared before and after the intervention. Means were tested for difference using a paired samples *t*-test and the difference for CO levels was significant, $t(6) = 2.622$, $p = 0.04$ whereas the CO_2 levels were not significantly different, $t(6) = 2.066$, $p = 0.084$

Air-Supply	**Pre- Intervention (N = 7)**		**Post-Intervention (N= 7)**	
Contaminant	*Mean (ppm)*	*Range (ppm)*	*Mean (ppm)*	*Range (ppm)*
CO	25.5	4.0-68.0	7.0	2.0-17.0
CO_2	430	400-500	400	400

Summary/Conclusions: Intervention reduced CO in the fishermen's air supply by 75% to acceptable levels. CO_2 levels do not appear to be at detrimental levels to these divers. This intervention could be applied to the rest of the fishing cooperative.

F 106

ORAL PRESENTATION TIME: 1554 - 1606
POSTER PRESENTATION TIME: 1630 - 1700
RESIDENT COMPETITION: NO

DIVERS WITH IMPLANTABLE CARDIAC DEVICES: CLINICAL CHARACTERISTICS AND VARIATIONS IN DIVING PRACTICE

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Background: Little is known about patients with implantable cardiac devices who continue to dive. Accordingly, we sought to identify the clinical characteristics, diving practices, and complication rates of this important population.

Methods: We invited divers with implantable cardiac devices, both pacemakers and defibrillators, to complete an online survey using the Qualtrics system on a secured server. Participation from eligible divers was invited using social media outlets. Of the 41 divers who contacted us, 29 were deemed eligible and took the survey. Divers who reported complications were contacted for clarification via a phone interview. Categorical variables were presented as frequencies and percentages, and continuous variables were given as medians (25^{th}, 75^{th} percentiles).

Results: The median age of respondents was 62 (56, 59) and 93.1% were male. Twelve (44.4%) reported pacemaker dependence. A substantial number (14/29, 48.3%) had a prior history of significant arrhythmia, including cardiac arrest (10.3%), ventricular tachycardia (13.8%), and atrial fibrillation (34.5%). The cohort continued aggressively diving post-device implantation, diving a median of 80 times (15, 200) to a median maximum depth of 100 feet (85, 110). Decompression diving was performed by 8 respondents (27.6%); 62.1% dive solo, and 75% dive >12 hours from a hospital. The population has a high prevalence of ongoing cardiac symptoms, including 40.7% with at least weekly presyncope and 14.8% with palpitations. Complications within 30 days of diving included an MI in one subject (3.7%) and decompression illness requiring hyperbaric oxygen therapy in another (3.7%). Specific advice on diving was given to 70.4% and varied from complete diving prohibition to no restrictions.

Conclusions: Patients with implantable cardiac devices who continue to dive have significant cardiac histories, high rates of pacemaker dependence, aggressive diving practices, and appreciable complication rates. These findings and the heterogeneity of professional advice given mandate further research and guideline development.

F 107

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1630 - 1700
RESIDENT COMPETITION: YES

BRAIN DAMAGE IN COMMERCIAL BREATH-HOLD DIVERS

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Objects: Decompression illness (DCI) affecting the brain is the most serious form of diving-related injury with potential sequelae. This study was conducted to investigate whether long-term breath-hold diving shows brain damage on magnetic resonance imaging (MRI).

Methods: Our study comprised 12 healthy commercial breath-hold (Ama) divers with long histories of diving in a district of Japan. We sought information on their diving practices and the presence or absence of medical problems, and neurological DCI events. All participants were examined with MRI to determine the prevalence of brain lesions.

Results: Among 12 Ama divers (54.9 ± 5.1 years), 4 divers had histories of cerebral DCI events after repeated breath-hold dives, and 11 divers demonstrated chronic ischemic abnormalities of the brain on MRI studies. The ischemic lesions were situated in the cortical and/or subcortical area (9 cases), deep white matters (4), the basal ganglia (4), and the thalamus (1). Subdural fluid collections were seen in 2 divers.

Conclusion: These results suggest that commercial breath-hold divers are at a risk of accumulating brain lesions, and that clinical or subclinical injury to the brain may affect the long-term neuropsychological health of divers.

F 108

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1630 - 1700
RESIDENT COMPETITION: NO

PROPOSAL FOR A NEW DECOMPRESSION ILLNESS (DCI) SEVERITY CLASSIFICATION BASED ON 98 DCI CLINICAL CASES AND OUTCOMES

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Background: DCI patients need recompression treatment immediately. However, the treatment of mild DCI is controversial. Additionally, a DCI severity classification has not yet been established.

Proposal: We propose a new DCI severity classification strategy based mainly on limb neurological findings. We defined DCI with only subjective symptoms as mild-1, and those with sensory disturbance and/or rash as mild-2 (mild-1 and 2 are subgroups of the mild group). Additionally, we defined DCI with muscle weakness as severe. The severe group was divided into 2 subgroups; severe-1 (Manual Muscle Testing: MMT＞3) and 2 (MMT≦3).

Materials and Methods: We classified 98 divers with DCI treated at our facility in 2012 by the new classification and retrospectively evaluated their clinical outcomes.

Results: The start of the recompression treatment was somewhat delayed from the DCI onset in these subjects (median 8 days, range 1-40 days); however, good clinical outcomes were obtained with treatment. Specifically, 58 subjects (59.2%) were healed, and 36 subjects (36.7%) had improved symptoms.
According to the new classification, 39 cases were mild (17 mild-1 cases and 22 mild-2 cases) and 58 cases were severe (54 severe-1 cases and 4 severe-2 cases). Only 1 case could not been classified because it was an inner-ear DCS with no motor weakness symptoms. There was an observed tendency in the severe DCI subjects (8.6±6.8 days) to recompress earlier than the mild DCI subjects (11.2±8.2 days, $p=0.061$); however, the severe DCI prognoses were poorer than the mild DCI prognoses ($p=0.049$).

Summary: Ninety-seven of the 98 cases could be classified by the new classification, and the new classifications seemed to correlate with patient prognoses.

F 109

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1630 - 1700
RESIDENT COMPETITION: YES

A CASE OF INTRAHEPATIC PORTAL VENOUS GAS WITH SYSTEMATIC GAS FINDINGS BY CT IN DECOMPRESSION ILLNESS

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Background: Decompression illness（DCI）occurs in divers and compressed-air workers. Although extra or intravascular bubbles are formed under inadequate decompression, it is difficult to detect gases using computed tomography (CT) or magnetic resonance imaging (MRI) in central nervous tissues or internal organs including blood vessels. We report a case of DCI with systemic gas detected by CT, and symptomatic improvement with elimination of abnormal CT findings by hyperbaric oxygen treatment (HBO).

Case presentation: A 54-year-old man complained of strong abdominal pain 3 hours after decompression associated with caisson work at 0.17 MPa. He was admitted to the hospital, which has a monoplace chamber for HBO, 7 hours after the onset of symptoms. Upon physical examination, there was evidence of numbness bilaterally in the lower extremities. Initial abdominal CT showed extensive intrahepatic portal venous gas occupying the terminal branches of vessels, as well as gas in the pulmonary artery and bilateral femoral vein. After a single treatment with HBO (2.5ATA 120min), the abdominal CT was negative for gas in both the portal vein and right-sided vessels. He was discharged 3 days later without abdominal pain or numbness in the bilateral lower extremities. He was referred to our hospital which has a multiplace HBO chamber. Upon the examination, Romberg's test remained positive. His symptoms completely disappeared after two of US Navy TT6 treatments.

Conclusions: It is possible to use CT to clearly visualize gas in DCI patients. The current case is the first to demonstrate systemic gas using CT in a DCI patient and to demonstrate the effect of HBO on systemic gas after treatment; a significant reduction in systemic gas was observed following HBO treatment. In addition, the current case points out that even though initial HBO treatment ameliorated most symptoms, the patient still required TT6 treatment. Thus, this case confirms that TT6 is still the first choice for DCI treatment.

F 111

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1630 - 1700
RESIDENT COMPETITION: YES

THE IMPORTANCE OF APPROPRIATE TREATMENT TABLE USE IN COMMERCIAL DIVING DECOMPRESSION SICKNESS

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Introduction: The commercial diving business in the Gulf of Mexico is a thriving enterprise. This work is technically difficult and dangerous, and decompression sickness (DCS) is a constant threat. This complex case highlights the importance of a rapid and correct diagnosis coupled with minimal treatment delays.

Case Presentation: A 21 year-old commercial diver was hand jetting for 60 minutes at 103 fsw. The diver surfaced and began his decompression obligations in the DDC. During this treatment, the diver had a seizure. The company's on-shore diving physician recommended a USN Air Table 1A.

Following treatment, the patient continued to be confused and unable to perform his deck duties. He reported memory lapses, headaches, and mood swings. Six days later, diver met with company diving physician and was diagnosed with anxiety/PTSD. A brain MRI revealed sinusitis. The patient was prescribed Flonase and 5 HBO2 tailing treatments.

The patient reported transient improvement following HBO2 therapies, without lasting effects. Fifteen days following the injury, the patient sought a second opinion. Our provisional diagnoses were an oxygen toxicity seizure with DCS. We recommended continued HBO2 therapy until symptom plateau, serial evaluations, brain SPECT imaging, and detailed neuropsychometric testing.

Neuropsychometric testing revealed cognitive deficits. However, the patient reported symptomatic improvement. The symptoms recurred with treatment interruptions. He was serially evaluated for several weeks until symptom plateau. The initial SPECT brain imaging revealed "defects in the parietal lobes." Repeat SPECT imaging was read as "normal."

Conclusions: This case highlights the importance of a correct initial diagnosis prior to the use of HBO2 treatment tables and a low threshold for the diagnosis of DCS. The symptoms of DCS may be subtle and vague, and delays in treatment can result in devastating consequences.

F 112

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1630 - 1700
RESIDENT COMPETITION: YES

COMMERCIAL DIVING INJURIES: THE PSYCHOSOCIAL AND ECONOMIC FACTORS THAT CHALLENGE THE APPROPRIATE MANAGEMENT

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Introduction: When a diving incident occurs, a multitude of factors may influence a commercial diver to minimize or deny injury, including: fear of job loss, self-denial, lack of knowledge, financial loss, or embarrassment. Moreover, reported injury may be complicated by liability issues and/or legal action.

Case Presentation: A 31 year old experienced commercial diver, maintained that he was "perfectly fine" following two separate diving incidents. The first was an "asymptomatic" omitted decompression due to an equipment malfunction following dive to 160 fsw (total bottom time 35 minutes). The bell propelled the diver to the surface. He was treated with USN TT6. The patient spent the next three days performing 12-hour daily shift work on deck. The second incident occurred the next day, during a dive to 161 fsw (total bottom time of 32 minutes). The dive was completed without complications. However, 90 minutes after surface decompression, he developed sudden neurological symptoms and lost consciousness. He received a USN TT6 with 2 extensions. Again, the patient reported he was "perfectly fine." However, the company diving physician subsequently informed the patient he had a large PFO and could only return to work when completely asymptomatic (with PFO repaired). The diver then "confessed" that he had been experiencing a whole gamut of symptoms since the first dive, most prominently persistent debilitating bitemporal headaches. The patient was referred for a second opinion.

Results: The patient received five hyperbaric tailing treatments and serial examinations. The patient did not respond to treatment, and HBO2 therapy was discontinued.

Summary/Conclusion: Decompression sickness is a complex injury that can be complicated by psychosocial and economic stressors. Additional factors include incomplete documentation and contradictory histories. These factors may lead to delayed treatment and risk residual injuries.

F 113

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1630 - 1700
RESIDENT COMPETITION: YES

CHRONIC DCI COGNITIVE DYSFUNCTION IMPROVED WITH HYPERBARIC OXYGEN: A CASE REPORT

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Background: A 27 year old female underwent altitude chamber training on July 26, 2012. During the hypoxia demonstration, she experienced onset of tingling in her left leg/arm and right leg. She started 100% oxygen without resolution, and then had difficulty responding to attendants. She could hear them, but could not speak back. She received two hyperbaric treatments locally after which her symptoms improved, but did not completely resolve. The patient was evaluated by neurology, psychiatry, psychology, and aerospace medicine specialists for continued symptoms and referred 14 months after the incident.

Materials and Methods: As the patient deployed multiple times, she had a number of Automated Neuropsychological Assessments Metrics (ANAM) tests. Prior to the 59 hyperbaric oxygen (HBOT) exposures at 2.0 ata, another ANAM was administered to create a pre-treatment baseline (June 25, 2013). Serial ANAM tests were done after every 10 treatments and compared to the pre-treatment baseline and her last predeployment (March 20, 2012) ANAM scores.

Results: The March 20, 2012 ANAM demonstrated average or above scores in all seven subtests whereas the June 25, 2013 scores were clearly below except for “matching to sample” test which was below average. The serial ANAM scores improved over the treatment course then plateaued with a score category of below average in “simple reaction time” and clearly below in another “simple reaction time” scale. The other five subtests were average or above.

Summary: This altitude training DCI case resulting in chronic cognitive dysfunction is the first case to our knowledge that has been treated after the normal timeframe. The availability of pre-incident cognitive function testing allowed us to objectively measure improvement during the HBOT series. This has potential impact for similar cases in diving and altitude as well as other bubble related etiologies, including surgical induced air gas emboli and blast injury.

F 114

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1630 – 1700 (will be presented during Session D: 1530-1600)
RESIDENT COMPETITION: NO

PULMONARY FUNCTION RESPONSE TO RECREATIONAL-TECHNICAL CLOSED-CIRCUIT REBREATHER TRIMIX DIVING

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Introduction: Extreme diving exposures, typically professional, have been associated with transient changes in standard measures of pulmonary function. In contrast, single, shallow, short duration recreational dives reportedly produce little change. Recreational-technical divers now commonly complete dives far in excess of traditional recreational limits. The acute responses to these extended range exposures, particularly with closed-circuit rebreathers (CCR), have not been fully investigated. We sought to evaluate pulmonary function changes following recreational-technical CCR dives beyond 60 msw (200 fsw) in depth.

Methods: Pulmonary function was assessed in 18 volunteers (11 male, 7 female) (51±6 y, 83±17 kg, 26.6±3.1 $kg \cdot m^{-2}$ BMI) before and shortly after open water CCR dives of their choice (trimix: 9-10% oxygen, 50-60% helium, balance nitrogen). Standard spirometric measures (MIR Spirobank II™) included forced vital capacity (FVC), forced expiratory volume in one second (FEV_1), and forced expiratory flow 25-75% (FEF_{25-75}). Data presented as mean±SD with ranges, as appropriate. Comparison of pre-/post-dive spirometry measures completed with ANOVA (significance accepted at $p<0.05$).

Results: Forty-two dives were captured (76±13 [60-96] msw [248±42 {196-315} fsw]; 130±41 [55-260] min total run time; 28±4 [11-31]ºC water temperature; the 4^{th}±2^{nd} [2-8] dive of the current series). Pre- and post-dive values, respectively, were: FVC 4.79±1.02 L (111±18% of predicted) vs. 4.80±1.08 L; FEV_1 3.68±0.90 L (104±20% of predicted) vs. 3.66±0.93 L; FEF_{25-75} 3.37±1.37 L (90±33% of predicted) vs. 3.33±1.32 L; and FEV_1/FVC 0.77±0.07 (95±9% of predicted) vs. 0.76±0.08. Tests were performed 66±23 (24-103) min pre-dive and 18±9 (2-58) min post-dive.

Conclusions: We did not find significant differences in pre- and post-dive pulmonary function with recreational-technical CCR dives in series conducted primarily in tropical waters. Studies of even more extended or repetitive exposures, capturing all dives in a series and with measures taken immediately pre- and post-dive, may be valuable to determine thresholds to induce changes.

F 115

ORAL PRESENTATION TIME:
POSTER PRESENTATION TIME: 1630 - 1700
RESIDENT COMPETITION: NO

THE "SKIN BENDS' HYPOTHESIS: DO EXTRAVASCULAR BUBBLES CAUSE "SKIN BENDS?'

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Introduction: Bubbles appear to form in the 40-50 µm thick extravascular epidermis of the skin, not adjacent to capillaries that are located below in the dermis. As they expand, can these bubbles invade the dermis causing the rash and itching of 'skin bends,' the bloodless cutaneous lesions reported during counterdiffusion, and the intravascular gas observed after decompression or during cutaneous counterdiffusion (Bove, ed. Diving Medicine. 4th ed: Saunders; 2004:127-164)? If rash and itching is a histamine response to the presence of bubbles that increases capillary porosity, the probability of bubbles entering the capillary blood might increase. An antihistamine, on the other hand, might decrease this probability by reducing capillary porosity. These effects could be particularly important in fenestrated vessels where discontinuous basal lamina with openings of 30-40 µm allow passage of 7.5-25 µm red and white blood cells.

Methods: Is this hypothesis testable? If a dive profile that reliably produced 'skin bends' could be identified, volunteers in a double blind human trial might make two identical dives receiving a placebo before one and an antihistamine before the other. Should bubbles that putatively cause 'skin bends' originate extravascularly, then rash, itching, and venous gas emboli (VGE) detected by echocardiography might be more likely after the placebo dive than after the antihistamine dive.

Discussion: The issue of whether bubble formation is intra- or extravascular is significant for understanding the mechanisms of mild (peripheral) and serious (neurological) decompression sickness (DCS) and for formulating DCS probability models that differentiate between mild and serious DCS (Vann. UHM 39(5):1038-1039). A test of the 'skin bends' hypothesis might clarify the role of VGE in serious DCS.

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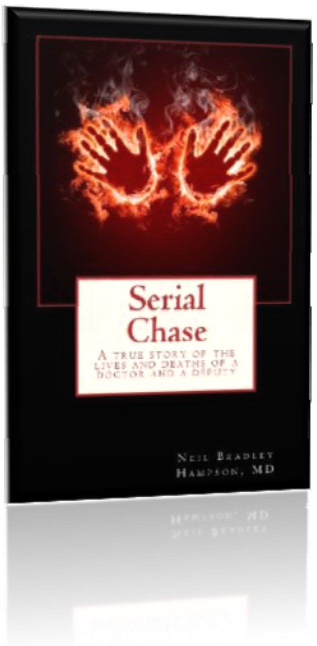
AUTHOR LIST

Book Signing: Friday, June 20: 3:00-3:30pm

"Serial Chase"

Neil B. Hampson, MD, FUHM



After two decades of writing medical articles and book chapters, UHMS Past-President Dr. Neil Hampson has entered the world of nonmedical authors with publication of his book *Serial Chase* in March 2014. It is the nonfiction recounting of the murder of his grandfather at the age of 52 in 1950 by a serial killer.

Se*rial Chase* is the true story of the tragic intersection of two lives in a hotel bar one night in Everett, Washington in 1950. One individual is a prominent 52-year-old optometrist, while the other is a 21-year-old man in a Sheriff's posse special deputy uniform. The optometrist appears inebriated when he stands to leave and the young man volunteers to drive him home.

An hour later, they arrive at the hospital emergency entrance, the passenger dead of apparent heart attack according to the deputy. He accompanies other deputies to the doctor's home where they explain her husband's death to his stunned wife. The young deputy expresses that he wishes he could have done more to help. The doctor is buried with the presumptive cause of death being a heart attack.

Thirteen months later, the former posse deputy is himself being held in the county jail on charges of arson. One night in his cell, he confesses to a spree of serial killing, arson, robbery, assault, and production of pornography, starting when he entered the army at age 17 and ending with his arrest at age 22.

The optometrist was the author's grandfather, murdered by the killer. The book reviews his life path to that bar stool in December 1950. The book then explores the life of the Sheriff's posse deputy, Harold Glenn Chase, and his path through acts of arson, murder, and a myriad of other crimes. The story follows the man through his murder trials, and how he used his incredible powers of persuasion to deceive a prison psychiatrist and spend less than a decade in the state penitentiary, despite having been sentenced to life imprisonment.

Dr. Hampson will be available at the 2014 Annual Scientific Meeting for book signing. The retail price for the book is $12.99 but Dr. Hampson will have 50 copies available at an author's discount price of $10.00.

"If you are looking for quick romantic story to read before drifting off to sleep, this is not your book. I started reading it and couldn't put it down. The the transcripts from the prison interviews are chilling. This is a sad but true story of a doctor with a mysterious life, a deputy with twisted mind, and an author obsessed with finding the facts of the case decades later. A must read." James Holm, MD

Book Signing: Thursday, June 19: 3:30pm-4:00pm

"To the Very Depth"

Peter B. Bennett, PhD, DSc, FUHM

Written by Chris Bennett, MBA

To the Very Depths provides tremendous insight into one of recreational scuba diving's brightest and well known scientific and business minds. My father's life is full of personal and professional accomplishments and this book provides a firsthand perspective. Few of us have the opportunity to enjoy such an exciting and interesting journey that includes worldwide travel, cutting edge scientific research, medical publishing, and business innovation.

He is also a great teacher and mentor and he discusses relationships with many of his colleagues and friends throughout *To the Very Depths*. I've been fortunate that he shared many of the values learned from his father, including the importance of education, hard work, passion, and family. AS you follow his life story, it is easy to understand why so many people, including me, are appreciative of his contributions. He has always made a commitment to helping people, from injured scuba divers to students and medical professionals, wanting to learn from his vast array of knowledge.

The insight into his life and many accomplishments makes for a compelling read. With scientific contributions that include world record human deep dives to the founding of Divers Alert Network, the international leader in recreational diving safety and health, my father is widely recognized as a major contributor and innovator within the industry. I encourage everyone with a passion for scuba diving to read this book.

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Thank you for your interest in joining the Undersea & Hyperbaric Medical Society. Our membership is committed to research, sound treatment, and education in the fields of diving medicine, hyperbaric oxygen therapy and wound care. Members receive a subscription to the *Undersea & Hyperbaric Medicine* Journal (except Associates who opt out, see below), our Membership Newsletter, *Pressure*, and discounts on all UHMS meetings, publications, and library services. So that we can best serve all our members, please complete the information below as completely as possible. Thank you for becoming a part of our membership community!

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2014 ANNUAL SCIENTIFIC MEETING EVALUATION

In an effort to "GO GREEN" and improve the efficiency in evaluating our CME Program, we now offer the evaluation form online. A hard copy evaluation form can be provided upon request. Thank you for supporting our efforts to help reduce our carbon footprint.

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