EUBS

EUROPEAN UNDERWATER & BAROMEDICAL SOCIETY

43RD ANNUAL SCIENTIFIC MEETING

RAVENNA (ITALY), 12-16 SEPTEMBER 2017

Abstract and Conference Book

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SCIENTIFIC PROGRAMME OVERVIEW

		September, 12 TUESDAY	September, 13 WEDNESDAY	September, 14 THURSDAY	September, 15 FRIDAY	September, 16 SATURDAY
8.30	9.00		DMAC Workshop: Nutrition and hydration for saturation divers. Medical aspects of hyperbaric evacuation.	Diving Medicine Research *Oral PresentationDiving Medicine Research Oral Presentation*	Diving Medicine Physiology *Oral PresentationDiving Medicine Physiology Oral Presentation*	HBOT and Diabetes
9.00	9.30					
9.30	10.00					
10.00	10.30					
10.30	11.00			HBO for intensive care *Oral Presentation HBO for intensive care Oral Presentation*	HBOT *Oral Presentation HBOT Oral Presentation*	Diving Medicine-Clinical Aspects *Oral PresentationDiving Medicine-Clinical Aspects Oral Presentation*
11.00	11.30					
11.30	12.00					
12.00	12.30	Foyer REGISTRATION Palazzo dei Congressi - Foyer				
12.30	13.00		11.30 - 12.40 POSTER SESSION			EUBS GENERAL ASSEMBLY
13.00	13.30		LUNCH			
13.30	14.00		HBO and neuroscience: What should a hyperbaric physician know about the brain?	EUBS_SPUMS_UHMS International Session	ECHM Workshop: The role of HBO on mitochondrial functions, oxidative stress, cell signaling and chemokines	
14.00	14.30					
14.30	15.00					CLOSING CEREMONY
15.00	15.30	Master Classes? Young Investigators		Oncology, Radiotherapy and HBOT workshop: perspectives for the research		
15.30	16.00					
16.00	16.30		SINSEC Sister Society: Right-left shunt: a multidisciplinary approach			
16.30	17.00					
17.00	17.30			Baromedical Session: Application of Standards for Hyperbaric Technology		
17.30	18.00					
18.00	18.30	OPENING CEREMONY KEYNOTE PRESENTATIONS				
18.30	19.00					
19.00	19.30					
19.30	20.00					
20.00	20.30	WELCOME RECEPTION	GET-TOGETHER PARTY	STRING QUARTET CONCERT - BASILICA DI SAN VITALE	CONFERENCE DINNER	
20.30	21.00					

SCIENTIFIC PROGRAMME

Time	Author	Title	No.	Page

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12:00 - 18:00	Registration desk open			
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	Chairman: C. Balestra			
15:00-15:20	C. Balestra	Statistical aspects of a research protocol		
15:20-15:50	V. Papadopoulou	Specificity, sensitivity, likelihood		
15:50-16:20	C. Balestra	Hypothesis testing		
16:20-1650	C. Balestra	Some hiccups in statistics		
16:50-17:10	C. Balestra, A. Galvani	Power and sample size		
17:00-17:30	E. Menegatti	Ultrasonic JVP for investigation of the heart-brain axis		
17:30-18:00	Test			
18:00-20:00	**EUBS Annual Scientific Meeting - Opening Ceremony**			
	S. Cassisi	The space and the oceans: diving in the unknown.		
	V. Lionetti	That heart too big over the seas: what to do?		
	P. Zamboni	Self-assessment of the jugular venous pulse from space and special environments		

20:00-21:00	**Welcome Reception**			

Wednesday, September 13, 2017				
08:30-12:30	**DMAC Workshop: "Nutrition and hydration for saturation divers. Medical aspects of hyperbaric evacuation"**			
	Chairmen: P. Bryson, M. Chines , J. Kot			
08:30-08:40	O. Eftedal	An introduction to the workshop		
	Nutrition and saturation diving			
08:40-09:10	S. Deb	The theoretical nutritional considerations during saturation diving		
09:10-09:40	C. Tjessem	The practical aspects of trying to deliver the theoretical nutritional needs		
09:40-10:10	E. Spisni	The relationship between nutrition and inflammation (oxidative stress)		
10:10 – 10:40	Coffee break			
	Emergency decompression procedures			
10:40-11:05	P. Bryson	The theoretical aspects of the resolute emergency decompression		
11:05-11:30	J.P. Imbert – J.Y. Massimelli	The theoretical and practical aspects of rapid decompression for medical cases		
11:30-11:55	F. Faralli	Emergency decompression procedures in military diving		
11:55-12:20	P. Della Torre	Case report		
12:30-13:00	**Poster Session**			
13:00-13:30	**Lunch break**			

13:30-16:00	**HBO and neuroscience: "What should a hyperbaric physician know about the brain?"**			
	Chairmen: P. Germonpré, O. Hyldegaard			
13:30-14:00	S. Efrati	Non Healing Brain Wounds -Basic Characteristics and the use of Hyperbaric Oxygen Therapy		
14:00-14:30	D. Cevolani	fMRI in brain injury		
14:30-15:00	A. Cantagallo	Rehabilitation and cognitive stimulation		
15:00-15:30	G. Anzola	Review of the available clinical data on HBOT in brain injuries		
15:30-16:00	Discussion			
16:00-18:30	**SINSEC Sister Society: "Right-left shunt: a multidisciplinary approach"**			
	Chairmen: C. Baracchini, . Balestra, P. Longobardi			
16:00-16:30	C. Balestra	PFO and the diver: is there a problem?		
16:30-17:00	P. Germonpré	Prospective study and divers' personality traits on PFO and DCS		
17:00-17:30	G. Anzola	PFO closure: approaching positive results?		
17:30-18:00	P. Limoni	Scuba divers and DCI: a multidisciplinary protocol		
18:00-18:30	Discussion			

Thursday, September 14, 2017				
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	J.P. Imbert	TECHNIP Deco Algo: a tool for the evaluation of decompression stress	O-02	13
	J.P. Imbert	Divers subjective evaluation of saturation fatigue	O-03	14
	D. Cialoni	Genetic predisposition to SCUBA Decompression Sickness	O-04	15
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	M. Pieri	Prevalence of venous gas emboli in repetitive breath hold diving: proposal for a new decompression algorithm	O-06	17
	V. Papadopoulou	Can current contrast mode echocardiography help estimate bubble population dynamics post-dive?	O-07	18
	R. Bedini	Innovative system for safety increase of divers in Commercial Diving	O-08	19
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	Chairmen: M. Brauzzi, M. Rocco, C.A. Volta			
	O. Castagna	Is cardiogenic pulmonary edema a critical step in the pathophysiological mechanism of drowning?	O-09	20
	P. Kronlund	Improved infection spread control with optimised Monoplace room design	O-10	22
	G. Akcalı	The relationship between intoxication severity and blood Interleukin 6, Interleukin 10 and CRP levels in Carbon Monoxide intoxicated patients	O-11	23
	P. Bothma	Prevention of iatrogenic gas embolism, what more can be done?	O-12	24
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	S. Passarani	Hyperbaric oxygen therapy (HBO) as alternative or supplemental therapy for brain radionecrosis after gamma knife surgery (GKS)	O-14	26
	R. Giacomello	Management of an Egyptian man (27 yo) with carbon monoxide poisoning in cardiocirculatory arrest	O-15	28
	I. Mezoughi	Carbon Monoxide poisoning: three years experience in the Tunisian hyperbaric center	O-16	29
12:30-13:00	**Poster Session**			
13:00-13:30	**Lunch break**			
13:30-15:00	**EUBS – SPUMS – UHMS International Session: "Development areas for hyperbaric treatments and technology in the future throughout the world"**			
	Chairmen: G. Bosco, P. Germonpre, E. Huang			
13:30-14:00	E. Huang	UHMS Clinical Practice Guidelines		
14:00-14:30	J. Kot	Hyperbaric Medicine in Europe: from education to practice		
14:30-15:00	V. Zanon	International research database: theoretical and practical remarks		
15:00-15:30	Discussion			
15:30-17:30	**Oncology, Radiotherapy and HBOT workshop: "Perspectives for the research"**			
	Chairmen: D. Amadori, C. Balestra, P. Pinton			
15:30-15:50	D. Arpa	Radiotherapy research project + HBOT in Glioblastoma		
15:50-16:10	A. Bolognini	HBO in head and neck cancer		
16:10-16:30	F. Fiorica	Radiotherapy Research Project + HBOT: clinical aspects		
16:30-16:50	C. Giorgi	Radiotherapy Research Project + HBOT: aspects of molecular biology		
16:50-17:10	A. Stefanelli	HBOT in Radiotherapy outcomes: clinical cases		
17:10-17:30	Discussion			
17:30-19:30	**Baromedical Session: "Application of Standards for Hyperbaric Technology"**			
	Chairmen: A. Chandrinou, J. Kot, E. Marchetti Discussant: G. Esentato			
17:40-17:55	E. Marchetti	The Italian job: coping with national and international safety standards		
17:55-18:05	R. Bedini	Scientific diving safety: rules, regulation and education		
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18:20-18:35	HIPERTECH	Hipertech Fire Fighting system according to EN16081+A1		
18:35-18:50	SIARE	Lung ventilator and vital signs monitoring in hyperbaric chamber		
18:50-19:05	J. Kot	Standards for Hyperbaric Technology: user expectations		
19:05-19:30	Discussion			

Friday, September 15, 2017

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	R. Arieli	A new mode of arterial decompression bubble development and spinal DCI	O-17	30

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	M. Gennser	Incidence of post-dive bubbles and DCS using the US Navy Revision 6 air decompression tables	O-21	34
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	A. Galvani	Pneumatosis intestinalis non-responder to HBOT: a successful case report of a patient treated by Hyperbaric Heliox.	O-29	35
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	A. Hadanny	The effects of hyperbaric oxygen on traumatic brain injury patients suffering from chronic neurocognitive delicts - correlation between cognitive functions and brain metabolic imaging	O-27	38
	Y. Bechor	The use of HBOT for patients suffering from fibromyalgia due to mental stress as result of child abuse.	O-28	39
	Y. Hachmo	Hyperbaric oxygen therapy can modulate immune system regulation of healthy aging human volunteers	O-30	40
12:30-13:00	**Poster Session**			
13:00-13:30	**Lunch break**			
13:30-16:30	**ECHM Workshop: "The role of HBO on mitochondrial functions, oxidative stress, cell signaling and chemokines"**			
	Chairmen: J. Kot, A. Marroni, A. Tesei			
	Session 1			
13:30-13:50	M. Ravaioli	Graft preservation (improved oxidative stress and mitochondrial activity) with hypothermic machine perfusion (HMP) and the addition of hyperbaric oxygen (HBO) during perfusion		
13:50-14:10	A. Tolomelli	HBOT and integrins		
14:10-14:30	A. Bertani	Chronic Intestinal Inflammatory Disease and HBOT		
14:30-14:50	C. Arienti	State of the Art of the Research in oncology and HBOT		
14:50-15:10	Coffee break			
	Session 2			
15:10-15:30	D. Mathieu	Advanced research update on HBOT in wound healing		
15:30-15:50	P. Zamboni	Adipose Derived Stem Cells and HBOT in wound healing		
15:50-16:10	V. Hartwig	NIRS 2D to predict the Venous Leg Ulcers healing trajectory in HBOT patients		
16:10-16:30	D. Melandri – E. Bondioli	Regenerative Medicine in Wound Healing		
16:30-17:00	Discussion			

20:00-23:00	**Conference Dinner**			

Saturday, September 16, 2017				
08:30-10:30	**Special Session: HBOT and diabetes**			
	Chairmen: R. Anichini, P. Di Bartolo, D. Mathieu			
08:30-09:00	L. Rogers	Models of Care to Prevent Amputations		
09:15-09:30	R. Anichini	Epidemiology and clinical path of care of the diabetic foot		
09:30-09:45	R. Da Ros	Diabetic Foot Acute Phase		
09:45-10:00	M. Di Filippi	Implementation of the Emilia-Romagna's Diabetic Foot Clinical Pathway in local health services		
10:00-10:15	D. Mathieu	HBOT in DFU		
10:15-10:30	Discussion			
10:30-12:30	**Scientific Session: Diving medicine - clinical aspects**			
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	F. Guerreiro	Decompression illness in extreme breath-hold dive (Taravana syndrome) - a case report	O-39	47
	Z. Wang	Efficacy of early treatment of decompression sickness in an on-site facility vs. delayed treatment of decompression sickness in an off-site facility.	O-40	49
12:30-14:30	**EUBS General Assembly**			
14:30-15:00	**Closing Ceremony**			

Sunday, September 17, 2017 – SIMSI Special event				
Location	**Marina di Ravenna**			
08:30-15:30	**Diving experience into the oil platform wreck "Paguro"**			
	Open to all participants – briefing in Italian and English			
15:30-18:30	**SIMSI in tour – Aggiornamente sull'attività subaquea (Update on diving activities – in italian)**			
	Chairs: C. Costanzo, R. Infascelli			
	Consulta delle didattiche Subaquee - Diving Instructional Council	L'approccio alla sicurezza Educational Standards for Safe Diving		
	P. Longobardi	In forma per immergersi bene (Look Good, Dive Better)		
	F. Fontana	Ergonomia del subacqueo (Ergonomics of diving)		

Scientific Posters @ EUBS2017

O-01 CAN SONIC VIBRATIONS INCREASE THE NUMBER OF DECOMPRESSION VASCULAR GAS EMBOLI?

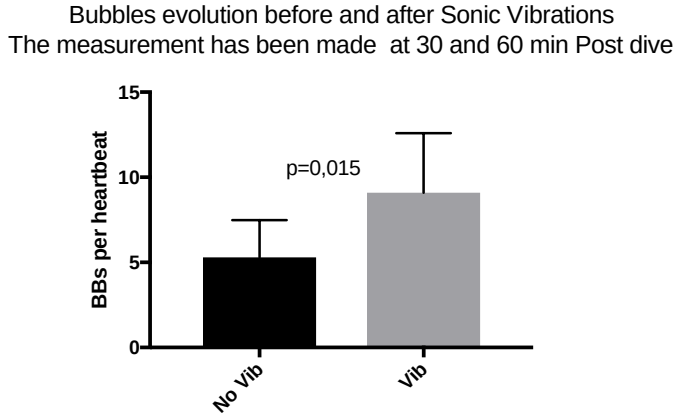
Costantino Balestra [(1)] - Mathieu Rousseau [1)] - Danilo Cialoni [(2)] - Sigrid Theunissen [(1)] - Guy Vandenhoven [(1)] - Peter Germonpré [(3)]

Haute Ecole Bruxelles-Brabant He2b, Environmental & Occupational (Integrative) Physiology Laboratory, Bruxelles, Belgium [(1)]
DAN Europe Foundation, DAN Europe Research, Roseto Degli Abruzzi, Italia [(2)]
Center for Hyperbaric Oxygen Therapy, Military Hospital Queen Astrid, Brussels, Belgium [(3)]

Introduction:
Underwater diving exposes SCUBA divers, breath-hold divers and marine mammals to a risk of decompression sickness (DCS) caused by nitrogen bubbles. The presence of vascular nitrogen gas emboli (VGE) after a dive is generally accepted to be a risk for DCS. We postulated that divers (humans or others) subjected to powerful enough sonic vibrations (under or out of water) during the decompression phase may experience an increased production of VGE enhancing DCS risk.

Methods:
During a standardised dive experiment (33m/20 min.) in a warm, fresh water deep pool (Nemo33 Brussels), 6 divers (known as consistent bubblers), of comparable age, weight, height, BMI, lifestyle and physical condition performed one dive. No diving or heavy physical exercise was allowed 48 hours before the dive.
Post-dive VGE production was measured by transthoracic echocardiography according to a previously described protocol of quantitative bubble counting 30 and 60 min. after the dive. A 4-cardiac chambers view was recorded and at least 10 heart beats were measured. The diver was lying in left lateral decubitus on a large air inflated mattress during the entire measurement. Inside the mattress, a bluetooth woofer was inserted, through which sonic vibrations (20 to 30Hz) could be delivered when chosen. Ten more heartbeats were measured while exposed to sonic vibrations. The measurements were repeated at 30 and 60 min post dive.

Results:



Conclusion:
Sonic waves ranging from 20 to 300 Hz, may increase decompression bubbles production when applied to a decompressing mammal. Some concern may be raised for humans and other "diving" mammals. This environmental noise pollution may also explain some DCS signs in stranded cetaceans, and/or some unexplained DCS experienced in humans.

Key words: DCS, Sonic Vibration, Bubbles, Underwater Noise Pollution, Prevention

O-02 TECHNIP DECO ALGO: A TOOL FOR THE EVALUATION OF DECOMPRESSION STRESS

Jean Pierre Imbert [1] - Murat Egi [2] - Costantino Balestra [3]

Divetech, N/a, Biot, France [1]
Galatasaray University, Computer Engineering Department,, Istanbul, Turkey [2]
Environmental & Occupational Physiology Laboratory, Haute École PH Spaak, Brussels Belgium [3]

Introduction:
TechnipFMC, a major diving services company, has conducted a 4-year research to define, measure and model decompression stress along two axes: bubbles and inflammation. An algorithm was designed that can follow a given decompression profile and compute the stress for a given diver.

Methods:
We first focused in the physical aspects of decompression. We then postulated that the diver's initial nanobubbles population directs the decompression: 1) nanobubbles are initially stabilized by the oxygen window, 2) nanobubbles expand and generate venous gas emboli during ascent, 3) nanobubbles containing oxygen create free radicals and oxidative stress.
We then introduced individual variations. We postulated that the number of nanobubbles relates to the heart rate range, which depends on age, gender and fitness. Because nanobubbles are sensitive to vibrations we also linked the diver's population to his "life style" (sports induced vibrations).
The combination of the two models allowed following a given dive profile and describes the nanobubbles evolution, leading to venous gas emboli and vascular dysfunction.

Results / validation:
The algorithm was first verified against Buhlmann tables.
The algorithm was then calibrated with 49 divers monitored during North Sea saturations by fitting model predictions (least square differences) to the actual bubbles counts and FMD variations.
Finally, the algorithm was validated by reproducing a series of 250 experimental air dives, conducted by 50 subjects, with the same order of least square difference as for saturation divers.

Discussion / conclusion:
The algorithm demonstrated a good prediction of the decompression stress, plot versus bubbles and inflammation axes, for a number of individuals exposed to different dives. It brings a new light on the relation between PPO2 and rate of ascent. It provides a tool for studying complex situations like the influence of night stops, decompression time, post saturation intervals, etc.

Key words: Saturation, Decompression, Algorithm

O-03 DIVERS' SUBJECTIVE EVALUATION OF SATURATION FATIGUE

Jean Pierre Imbert [(1)] - Fatima Zohra Kiboub [(2)] - Costantino Balestra [(3)]

Divetech, N/a, Biot, France [(1)]
TechnipFMC, QHSE Department, Stavanger, Norway [(2)]
Environmental & Occupational, Physiology Laboratory, Haute École PH Spaak, Brussels Belgium [(3)]

Introduction:
Saturation diving is the main method of intervention in offshore diving. TechnipFMC, a major diving services company, conducted a two year, large-scale monitoring survey to assess the divers' subjective evaluation of their saturation exposures.

Methods:
The study involved 70 divers during North Sea saturations both in the UK and Norwegian sectors.
Information was collected confidentially through questionnaires and interviews after divers' decompression.
Topics surveyed included: fatigue, thermal comfort, sleep, exercise during decompression, headache, skin problems and post sat fatigue.

Results:
The study revealed different personal strategies to cope for the long decompression time: slight physical activities (40%), increased drinking (74%) or complement vitamins (59%).
It confirmed a subjective post saturation fatigue and a perceived recovery time of 3 to 7 days.
The fatigue was described as physical (95%) more than mental. It was generally defined as a limitation to effort (like climbing stairs and becoming breathless). The overall well-being, capacity to focus, mental alertness or mood was not affected.
Headache was often reported in the last day of decompression or just after arrival at surface (60%).
Sleep duration increased during decompression. However, 95% of the diver reported bad quality or interrupted sleep.
Few skin problems (22%) and nose/eyes irritation (33%) were mentioned.
No significant difference was found between UK and Norwegian (NORSOK) saturation procedures.

Discussion / conclusion:
The fatigue described and associated headaches suggest a diver's acclimatization to elevated oxygen partial pressures during saturation, inducing hypoxia symptoms similar to mountaineering when returning to normal.
Attitude and individual variations make recovery time different from one diver to the other but all reported full recovery within a week.

Key words: Saturation diving, Saturation fatigue

O-04 GENETIC PREDISPOSITION TO SCUBA DECOMPRESSION SICKNESS

Danilo Cialoni [(1)] - Massimo Pieri [(1)] - Costantino Balestra [(1)] - Vittorio Lucchini [(2)] - Alessandro Marroni [(1)]

DAN Europe Foundation, DAN Research, Roseto Degli Abruzzi, Italy [(1)]
NGB Genetic, Università Di Ferrara, Ferrara, Italy [(2)]

Introduction:
The popularity of SCUBA diving is steadily increasing together with the number of dives and correlated diseases per year (1). The link between circulating Vascular Gas Emboli (VGE) and DCS is well accepted, as well as the presence of "silent" VGE in many divers without any DCS symptoms (2). The aim of this study is to investigate if some genetic variants are possible DCS risk factors.

Materials and Methods:
Twenty male and female experienced healthy SCUBA divers were investigated by transthoracic echocardiography recorded before and 30 minutes after a dive. Bubbles were graded according to the EB scale (3) and divided in No-Bubblers (NB) (grade zero to 1 of EB scale) and Bubblers B (grade 2 and above of EB scale).
We looked for any differences between B and NB subjects for variants of selected genetic polymorphisms aiming at identifying the variants most frequently associated with bubble formation.
Total DNA was isolated from epithelial oral cells using two buccal swabs for each individual. Two genes, ACE (ID) and eNOS (rs1799983, rs2070744), were selected because a previous study had associated them to individual predisposition to other underwater ilnesses. The others selected genes are involved in methylation and vitamin B metabolism, detoxification and antioxidant) and inflammation response.

Results:
We did not find any clear relationship between the investigated genetic variants and B subjects ($p > 0.05$). However the inflammation polimorphism showed a non statistically significant difference, apparently linked to the low numbers of investigated subjects, while showing a trend to a possibly significant correlation in case of a larger sample.

Conclusions:
Our data show that, for the time being, it is not yet possible to identify a specific genetic polymorphism related to bubble formation although there is an indication that an increase in the investigated sample may lead to identify possible relationship with specific genetic variants.

References:
1. Trout, B.M., et al., in *DAN Annual Diving Report 2012-2015 Edition: A report on 2010-2013 data on diving fatalities, injuries, and incidents*, P. Buzzacott, Editor. 2015: Durham (NC).
2. Eftedal OS1, L.S., Brubakk AO, , *The relationship between venous gas bubbles and adverse effects of decompression after air dives.* Undersea Hyperb Med. 2007 Mar-Apr;34(2):99-105.
3. Eftedal O, Brubakk AO. *Detecting intravascular gas bubbles in ultrasonic images*. Med Biol Eng Comput. 1993; 31(6): 627-633.

Key words: Decompression Sickness, Genetic predisposition

O-05 DIVE RISK FACTORS, GAS BUBBLE FORMATION AND DECOMPRESSION SICKNESS IN RECREATIONAL SCUBA DIVING: ANALYSIS OF 39099 DIVES INCLUDED IN DAN EUROPE DSL

Massimo Pieri [1] - Danilo Cialoni [1] - S. Murat Egi [2] - Costantino Balestra [1] - Alessandro Marroni [1]

DAN Europe Foundation, DAN Research, Roseto Degli Abruzzi, Italy [1]
Galatasaray University, Computer Engineering Department, Istanbul, Turkey [2]

Introduction:
Diving related diseases are increasing with the increase of SCUBA Diving activities (1).
The rules that govern correct decompression procedures are considered well-known (2) even if little is still known about other diving risk factors and any individual predisposition to decompression sickness (DCS), particularly in light of its frequent occurrence notwithstanding respect of current decompression algorithms.
This study provides an in-depth epidemiological analysis of the diving community, to include additional risk factors correlated with the development of circulating bubbles and DCS.

Materials and Methods:
An originally developed database (DAN DB) including specific questionnaires for data collection allowed the statistical analysis of 39099 electronically recorded open circuit dives made by 2629 European divers (2189 males 83.3%, 440 females 16.7%) over five years.

Results:
Mean depth and GF High of all the recorded dives were 27.1 m, and 0.66 respectively; the average ascent speed was lower than the currently recommended “safe” one (9-10 m/min).
We found statistically significant relationships between higher bubble grades and BMI, fat mass, age and diving exposure. Regarding incidence of DCS, we identified additional non-bubble related risk factors, which appear significantly related to a higher DCS incidence, namely: gender, strong current, heavy exercise.
We found that the majority of the recorded DCS cases were not predicted by the adopted decompression algorithm and would have therefore been defined as “undeserved”.

Conclusion:
The DAN DB analysis shows that most dives were made in a “safe zone”, even if data confirm previous reports of our group showing an evident “grey area” in the “mathematical” ability to predict DCS by the current algorithms.
Some other risk factors seem to influence the possibility to develop DCS, irrespective of their effect on bubble formation, thus suggesting the existence of some other factors influence or enhancing the effects of bubbles.

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Keywords: Gradient Factor, compartmental model, Diving, Ascent speed, M-value

O-06 PREVALENCE OF VENOUS GAS EMBOLI IN REPETITIVE BREATH HOLD DIVING
PROPOSAL FOR A NEW DECOMPRESSION ALGORITHM

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Introduction:
Neurological symptoms after Breath-Hold-Diving (BHDg) have been well described, referred to as "Taravana syndrome" and considered as a form of Decompression Sickness (DCS) of breath-hold divers (BH-divers). Rrecently high grade bubble formation in (BH-divers) and also in a Taravana case was shown confirming the similarity with DCS in scuba diving.
The aim of this experiment was to look for any bubble formation during BHDg in a larger number of subjects to evaluate the prevalence of bubble formation and to test the possible application of a new decompression algorithm to BHDg.

Materials and methods:
Thirty-six subjects were investigated by transthoracic echocardiography before and after a BHDg training session. Some of these divers completed a very aggressive series of dives. Echocardiograms were recorded before the dive series and every 15 minutes until 90 minutes after the dive series was completed.
The theoretical aspect of a possible accumulation of inert gas during repeated breath hold dives was investigated using a new algorithm and a dive simulator, specifically modified to simulate BHDg characteristics.

Results:
We found bubbles in 38.9% of divers (27.8% low;11.1% high) Bubblers (B) while 61.1% of the divers did not show any bubble, Non Bubblers (NB).
B performed diving profiles reaching the bottom of the swimming pool, long bottom time and short recovery compared to NB ($p < 0.005$).
The new algorithm permits to calculate a significant difference in the computed inert gas accumulation between the B and NB divers ($p < 0.05$).

Conclusion:
Our work confirms that bubble formation during BHDg is not only possible, but unexpectedly occurs in a very high number of subjects (38.9%) in case of specific diving profiles (very deep, with long bottom time and short surface recovery).
This study confirms that our new approach to calculate computed inert gas accumulation in BHDg permits to intercept inert gas accumulation.

Keywords: Taravana; Breath-hold diving; Diving; DCS

O-07 CAN CURRENT CONTRAST MODE ECHOCARDIOGRAPHY HELP ESTIMATE BUBBLE POPULATION DYNAMICS POST-DIVE?

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Introduction / background / objectives:
Significant inter- and intra- subject variability is seen in venous gas emboli observed post dive using standard B-mode echocardiography, even for a same controlled diving exposure. We hypothesize that the ability to better estimate the quantity and size of decompression bubbles, in both the venous and arterial circulation, could inform degassing dynamics. We investigate whether commercially available contrast mode echocardiography can show signal increase corresponding to small microbubbles (<10μm) which are not resolvable on standard B-mode echocardiography (>35μm).

Methods:
Seven divers performed a standardized scuba dive to 400kPa for 20min at NEMO33, Brussels. 12sec contrast mode recordings, concurrently with standard echocardiography, were acquired on a portable ultrasound machine (Mindray M9, SP5-1S, MI 0.2), prior to diving and every 35min post dive for two hours. Image processing was used to extract the venous and arterial heart chambers for each recording and intensity histograms were compared within the regions of interest for each subject over time.

Results:
For all divers, contrast mode echocardiography showed that in both venous and arterial chambers: a) mean intensity increased post dive before decreasing again; b) intensity histograms predive were unimodal and shifted to a clear bimodal distribution post dive. The rate of bimodal distribution shift, the magnitude of intensity increase, and the intensity ratios between venous and arterial chambers, did not correlate with the amount of gas emboli seen on B-mode (0-29 counts).

Discussion / conclusion:
Further studies, including calibrations, are needed to fully interpret results, however the consistency seen in increased background intensity signal in contrast mode, even in the absence of detectable gas emboli on standard echocardiography, indicates that some signal from smaller bubbles are captured in contrast mode. Interestingly, this signal does not correlate to B-mode recordings that represents larger emboli, thus contrast mode echocardiography offers additional information.

Key words: Dual-frequency Ultrasound, Microbubble

O-08 INNOVATIVE SYSTEM FOR SAFETY INCREASE OF DIVERS IN COMMERCIAL DIVING

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Introduction:
During offshore commercial diving operations, very serious accidents are due to loss of dynamic position control of the support vessel. As a consequence, the diving bell shifts uncontrolled towards the sea surface and drags the divers connected through their umbilical. The divers' dragging can induce serious injuries related to the sudden change of the hydrostatic pressure and/or the possible interlocking or break of the umbilical.

Description:
We have developed and patented a special connector for umbilical, that is controlled by the diver for voluntary release from the bell to reach a survival cell, also subject of the patent, waiting for help. During the umbilical disconnection, the diver breaths by using his emergency bottle.
The connector is made of two interlockable metal and plastic shells, that contain the necessary piping for Heliox, gas reclaim, hot water, electrical and communication links. The connector is kept locked by the external hydrostatic pressure and, as additional safety, by a protective plastic shell. The opening of connector is controlled exclusively by the diver by means of a pneumatic or manual (in case of pneumatic command failure) operations, breaking the protection shell.
The survival open metal cell is composed by a cylinder pack of about 1.5 m3 of volume. It is filled with a thermal insulating gas mixture, ensuring a comfortable shelter for about hours of breathing time. Inside the survival cell, the diver can reconnect the connector to a proper socket that provides both the breathable mixture and communications by means of a transponder.

Our first tests were performed in a controlled pool environment of 10 meters. The disconnection and reconnection procedures resulted simple and effective for the divers. The disconnection was tested both by using the pneumatic and manual way.

The system operability of the connector resulted very satisfactory for the divers. At present, the complete system (both connector and survival cell) is under industrialization.

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O-09 IS CARDIOGENIC PULMONARY EDEMA A CRITICAL STEP IN THE PATHOPHYSIOLOGICAL MECHANISM OF DROWNING?

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University of Manchester, Biological Physics Group, Taunton & Somerset Hospital, Tauton, United Kingdom [(2)]

Introduction:
The pathophysiological mechanisms leading to drowning are poorly understood. Most authors propose that water inhalation leads to lung injury.[1-3] We hypothesise that, in many cases, IPE may precede drowning. We, therefore, undertook an investigation to study the mechanisms of IPE[4].

Methods & results:
We studied divers using echocardiography and lung ultrasound. We showed immersion alone induced an increase in cardiac preload demonstrated by increase in inferior vena cava diameter, right atrial area, tricuspid annular plane systolic excursion, right ventricular fractional area change and pulmonary artery pressure, left ventricle filling pressures but without a corresponding change in left ventricular stroke volume. Immersion during exercise increased the imbalance between left and right heart function further and these changes correlated with extravascular lung water accumulation (ie IPE). We also showed that the combination of negative pressure breathing and exercise amplifies these haemodynamic changes and causes IPE.

Discussion:
We suggest that a victim struggling in the water will be at high risk of developing IPE because of the combination of 1) immersion causing a fluid shift from the peripheral circulation into the chest, 2) intense physical exercise and 3) negative pressure breathing due to a) their lungs are located on average 20 cm below the level of the surface[5, 6] b) tachypnoea and increased inspiratory effort and c) water contact with the larynx causing reflex closure of the glottis and laryngospasm. Forced inspiration combined with laryngospasm will result in a major reduction in alveolar pressure. The combination of these changes result in IPE.
A greater understanding of the mechanisms of IPE such as a right/left ventricular stroke volume mismatch may help in reducing the likelihood drowning. To confirm our hypothesis, further studies on rescued subjects following near drowning are necessary to examine systematically for signs of both pulmonary edema and imbalance between the heart and left function.

Key words: Drowning, immersion pulmonary edema; negative pressure breathing; right/left heart stroke volume balance

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O-10 IMPROVED INFECTION SPREAD CONTROL WITH OPTIMISED MONOPLACE ROOM DESIGN

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Background:
Since better control of spreading pathogens around in hospital environment will be mandatory in the future, there will be an increased demand of hospital design to minimize this problem.
This was a main issue in designing the New Karolinska University Hospital and its department of Hyperbaric Medicine.

Methods:
Earlier design of monoplace rooms have often used open solutions with several monoplace chambers sharing the same area. This is of course convenient in respect of staff numbers.
Today and in the future there will be an increased number of severe infected patients and by that a high risk of contamination by staff, patients and inanimate surfaces.
In order to reduce this we went for a monoplace room design with single rooms.
In the room we have patient lifting device from the ceiling, patient monitoring device, staff workstation, auxiliary gas and electrical panels, staff alarms etc.
One of these rooms has also a hygiene room of its own with decontamination device and hardware washing machine.
By this, everything in the patient workflow can be done in one room with a minimal of staff contacts - thus reducing the risk of pathogen spreading.

Discussion:
Today we have a problem worldwide in maintaining spreading of pathogens in hospitals at a low rate. By effective room design, planning and looking at patient workflows there is a possibility to reduce these risks when planning new hospitals.
Of course, single ward rooms planning have the drawback of the need for increased staff numbers but compared with the cost of treatment of highly infected patients it is worth the cost.

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O-11 THE RELATIONSHIP BETWEEN INTOXICATION SEVERITY AND BLOOD INTERLEUKIN 6, INTERLEUKIN 10 AND CRP LEVELS IN CARBON MONOXIDE INTOXICATED PATIENTS

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Introduction:
Carbon monoxide (CO) is one of the most common causes of death due to intoxications both in our country and worldwide. There are no biochemical markers to address the severity of intoxication, so the evaluation of the patient is carried out by clinical examination and vital parameters. Herein, high sensitive C-reactive protein (hs-CRP), Interleukin-6 (IL-6) and Interleukin-10 (IL-10) are tested in order to define the possible role of determining intoxication severity.

Methods:
This study is a prospective clinical trial. Forty CO-intoxicated patients who referred to GATA Emergency Service and 40 healthy volunteers are included into the study. Blood samples are taken from the patient group at the time of first medical examination (0-hour) and after treatment (6-hours). Blood samples of healthy volunteers are also gathered. The serum was separated and stored at -80ºC untill the time of evaluation. IL-6 and IL-10 are studied by ELISA method while hs-CRP is quantified by turbidimetric analysis.

Results:
IL-6 and white blood cell count levels in the patient group at 0-hour was significantly higher compared to the control group (p=0.001; p<0.001 respectively). There were no differences between IL-10 and hs-CRP levels in the patient and control groups. IL-6 level at 6-hours was significantly higher than 0-hour level (p=0.014). This result is due to the patients in normobaric treatment group. The patient group was divided to treatment type (normobaric oxygen, hyperbaric oxygen), history of syncope and compared for IL-6, IL-10 and hs-CRP levels. No significant differences were detected in patients` subgroups regarding to IL-6, IL-10 and hs-CRP levels. Weak positive correlation was found between CO-Hb and Lactate levels in the patient group (p=0.013; r=0.390).

Conclusion:
This study shows that IL-6 level increases in CO intoxicated patients, but does not define the severity of the intoxication. IL-10 and hs-CRP levels did not increase in intoxicated patients in our study.

Keywords: Carbon monoxide poisoning, IL-6, IL-10, hs-CRP

O-12 PREVENTION OF IATROGENIC GAS EMBOLISM, WHAT MORE CAN BE DONE?

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Introduction:
We have a good idea how to treat need gas embolism cases when they present. We can do more to prevent iatrogenic gas embolism.

Methods:
MEDLINE search
Cases referred for HBO or submitted/discussed through the gas embolism website.

Results:
An overwhelming majority of articles, case reports and guidelines focus on vascular access techniques. Other preventative measures for different aetiologies are rarely mentioned and often completely ignored.

Discussion:
Iatrogenic CGE is uncommon, therefore organisational memory is a lot more likely to have an effect than individual memory:

1. Avoid 'excessive' pressures when inflating any body cavity with gas, e.g. laparoscopies, thoracoscopies, gastrointestinal endoscopies.
2. Carbon dioxide is the safest gas for insufflation.
3. Use of tissue glue and/ or a purse string suture to close the orifice left when big/long-term lines are removed. Keeping the patient supine for 30 minutes is not adequate in all cases
4. Continuous vigilance, careful monitoring and care by an experienced neuro anaesthetist in cases where neurosurgery in the sitting position has to be done.
5. Before any intravenous injection or infusion is started, the syringe or infusion set should be flushed by the person administering it. Having a 2nd person checking such systems as is done with IV injections given by nurses. The same applies to pressure transducer system setup.
6. Insufflation of carbon dioxide into the thoracic cavity is used in some centres for organ protection in cardiac surgery. This very old technique has seen a resurgence and currently a controlled randomised trial is taking place. Could this technique be expanded to other areas of operation?

Conclusion:
These measures may save lives and particularly as so many of these cases do not reach the hyperbaric unit in time for successful treatment, prevention may be better than cure.

O-13 EMERGENCY TREATMENTS PROFILE IN A CLINICAL HYPERBARIC CENTER – A CASE SERIES ANALYSIS.

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Introduction:
Emergency patients treated in Hyperbaric Medical Centers are becoming more challenging, demanding higher capabilities in terms of staff members, medical equipment and security requests. The aim of our study was to characterize the profile of urgent clinical situations treated with hyperbaric oxygen therapy (HBOT) in our Center, quantifying its dimension in our clinical activity spectrum.

Methods:
Retrospective and observational study of emergency patient's treatments performed in our Hyperbaric Center, between 1989 and April 2017.

Results:
2196 urgent patients have been treated, representing 97.5 % of all urgent patients (2251) referred to our Center. The majority (82.5%) were cases of carbon monoxide (CO) poisoning - these cases have a seasonal character, appearing mainly between October and March. Decompression illness (112 cases) represents only 5.1% of urgent clinical situations, occurring mainly among recreational divers. The 7 arterial gas embolism (AGE) cases were caused by invasive medical procedures. An increasing number of patients (78) with necrotizing soft tissue infections (NSTI) was treated in emergency context, posing a major challenge due to clinical severity. We treated 58 patients with central retinal artery occlusion (CRAO) - 55 in the last 8 years. Globally, we treated 2138 (97.3%) type 1 recommendations and 58 (2,7%) type 2 recommendations. Emergency patients represent 28% of the total number of patients treated in our Center.

Discussion:
CO poisoning remains the most important cause of emergency treatments in our service. Other conditions as NSTI and CRAO are growing fast, namely in the last five years. There was a gradual change in the profile of urgent patients - increasing levels of severity, associated namely to NSTI and AGE. Centers must be prepared for present and future challenges, promoting staff training and implementing well designed protocols.

Keywords: Hyperbaric Oxygen Therapy (HBOT), Emergency patients, CO Poisoning, Decompression illness, Necrotising soft tissue infections.

O-14 HYPERBARIC OXIGEN THERAPY (HBO) AS ALTERNATIVE OR SUPPLEMENTAL THERAPY FOR BRAIN RADIONECROSIS AFTER GAMMA KNIFE SURGERY (GKS)

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Asst Niguarda, Neurochirurgia, Milano, Italy [3]

Introduction:
Radionecrosis (RN) may occour in 5-50% of patients after GKS for brain malformation resulting in permanent damage in 2-5% of patients.
RN is due to blood-brain barrier disruption with consequent increase in vascular permeability and edema, moreover it seems to be related to a lack of angiogenesis and chronic inflammation.
HBO can produce a stabilization or even a relief of symptoms.
HBO improves cerebral edema reducing vascular permeability, and induces cerebral vasoconstricton with consequent reduction in cerebral blood flow. Injured areas don't respond to HBO with vasocontricton, with a consequent increase in blood flow and oxigenation.

Materials and methods:
After Ethic Committee approval, patients from 10 to 75 years affected with RN due to GKS with signed informed consent are eligible. We exluded patients with life expectancy shorter than 6 months, Rankin scale >5, contraindication to HBO.
After RMN and Rankin Scale evaluation, patients started HBO therapy (24 daily sessions/5 days a week, up to 40 sessions if no clinical/instrumental improvement). A HBO session consists in 90min at 2.4 ATA with oxygen in mask according to TAB 9 C.M.I.
RMN and Rankin scales were performed after 24 sessions and one month after the end of HBO or after the additional 16 sessions if needed.

Results:
Four patients completed the study after 24 sessions of HBO. Results are shown in the following table:

Patient sex	Age (yrs)	Pathology	Rankin score pre-HBO	Edema size pre-HBO AP/LL mm	Rankin score post-HBO	Edema size postHBO AP/LL mm
male	59	Cerebral metastases (pulmonary neoplasm)	3	52/41	1	37/31
male	55	Cerebral artery disease	2	61/32	1	34/18
male	68	Cerebral metastases (Melanoma)	2	48/43	0	33/35
female	45	Cerebral metastases (breast cancer)	3	77/53	4	65/45

Conclusion:
Every patient had a reduction in cerebral edema after 24 sessions, three of them had a relief in synptoms. In one case, we had a clinical deterioration, despite a RMN improvement. In this case, our neurosurgeon proceeded to a traditional surgical exeresis of a necrotic brain metastasis.
In all observed patients, HBO reduced RN-induced edema not affetting necrotic tumor tissue area. Data are not enough to draw conclusions, but they give us confort to continue with this study.

O-15 MANAGEMENT OF AN EGYPTIAN MAN (27 YO) BY CARBON MONOXIDE POISONING IN CARDIOCIRCULATORY ARREST.

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Case description:
The event happened on 12/01/17 at 14.45 in Milano. Some friends living with the patient called 112 for rescue, describing him unconscius with neurological symptoms. He was processed with red gravity code.
At 14.48, BLS had found the man unconscious with trismus, without signs of trauma, snoring breathing, open airway, unresponsive to pain. Also some blisters of amoxicillin and tachipirin, partly empty, were found.
At 15.10 BLS positioned Mayo cannula for trismus and delivered O2 100% in mask, with ACC during the emergency call. EMS continued ACLS and performed 3 analyses with recommended shocks, 1 mg of ephinefrine and asked for ECMO protocol activation. Contemporary, SOREU 118 was looking for CARDIO-ICU post equipped for ECMO.
At 15.28 San Raffaele Hospital becomes available to accept the patient.
ALS team at 15.20 confirmed ROSC, IOT 7.5 cuff is placed. Arythmia and bradycardia.
HR 55 bpm, BP140/70, SpO2 85%; ECG confirmed FA, HR 85 bpm, extrasystole in suspected infero-lateral IMA. Second ALS report suspected CO poisoning even if there were no surveillance of alarms. The friends had found the unconscious man in the bathroom with a water heater, and had moved him him into the bedroom later. Police and Fire Department were warned.

At 16.15 the patient reached the Intensive Cardiac Surgery, ECMO Center, with GCS3, ventilated, with hemodynamic stability without drugs, BP 120/70mmHg. No indication of ECMO treatment.
At 16.56, Echocardio negative, contemporary confirmed CO-Hb level of 18%.
Arterial blood gases: pH 7.14, pCO2 41.5 mmHg, pO2 381mmHg, BE-15.1mmol/L, HCO3- 13.9mmol/L, Hct 46%, THb 15.8g/dL, CO-Hb 18.6%, Lac 12.80mmol/L, Na+ 141.8mmol/L, K+ 2.97mmol/L, Glu 251mg/dL
At 18:45: Poison Centre of Milano confirmed the indication for HBO treatment.
ECG: RS, FC 73, Diffuse alteration of repolarisation, global acue heart ischemia
Echocardiogram: Normal FE%, VSX and global systolic function were normal.
At 18.00: Coronarography: coronary arteries IVA, CX, CDX all without stenosis injuries.
At 20:00 the patient arrived at Niguarda HBO Centre, was subjected to hyperbaric oxygen therapy (HBO) 2.8 ATA x 30 min x 3 FiO2=1. Mechanical ventilation IPPV 500 TV x 14 FR, IV infusion of Propofol and monitored.
Transferred at the end of treatment to HSR.
The next morning complete awakening of the patient without neurological deficit, troponin >500, he continued HBOT for 5 days.
After 15 days control RMN shows image compatible with a delayed neurologicla syndrome. Clinically without symptoms, difficult psycho-cognitive-behavioral survey for language barrier. Patient was further treated with another 5 HBOT sessions at 2.4 ATA 30 min x 3.

O-16 CARBON MONOXIDE POISONING: THREE YEARS EXPERIENCE INTHE TUNISIAN HYPERBARIC CENTER

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Introduction:
Carbon monoxide (CO) poisoning is the most common type of fatal poisoning in many countries. HBOT is indicated in many clinical presentations.
The aim of our study is to analyze clinical and epidemiological profile of CO poisoning managed in hyperbaric center.

Methods:
This is a retrospective descriptive study including all the victims of CO poisoning received for hyperbaric oxygen therapy (HBOT) in our facility for the last three years (2014-2016).

Results:
Five hundred twenty-nine (529) patients are included in this study: 337 women and 192 men. Mean age was 35±21 years. Exposure to defective water heating devices is the main source of accidents (89% of cases). The mean time of exposure was 2 hours. Loss of consciousness was the major symptom for HBOT indication in 73% of patients; seizures in 24% of the cases. Forty patients were comatose. Seventeen showed myocardial ischemia revealed by electrical modifications (7 cases) and high levels of troponin (10 cases). Pregnancy was involved in 22% of the cases. CO-Hb levels were tested in 30% of cases and the average was 21%. Mean time before HBOT session was 7 hours. Most patients received one HBO session, only 10 cases needed more sessions. Immediate outcome was favorable in most cases. Twenty patients showed minor HBOT complications (middle ear barotraumas). Four patients died because of initial severe neurological impairment and late medical care.

Conclusion:
While treating CO poisoning, HBO should be considered in case of loss of consciousness, seizures, coma, pregnancy and patients with persistent cardiac ischemia. Treatment should be performed as early as possible to help prevent delayed neurologic sequelae**.**

Key words: Carbon monoxide (CO) poisoning- HBOT- epidemiology

O-17 A NEW MODE OF ARTERIAL DECOMPRESSION BUBBLE DEVELOPMENT AND SPINAL DCI

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Introduction:
Because active hydrophobic spots (AHS) are to be found in blood vessels within the arterial as well as the venous circulation, with a distribution going as far as the cerebral capillaries, one ought to consider the possibility that bubbles may develop within the arteries. This mechanism can explain symptoms of neurologic decompression sickness which appear without arterialization of venous blood, either via a patent foramen ovale or intrapulmonary arteriovenous anastomoses. After decompression, inert gas is released from the pulmonary capillaries to the lung. However, at any arterial bifurcation, flow decreases for each vessel with the distance from the heart along the arterial tree. The vessel's diameter is reduced, which increases the surface area available for diffusion with respect to blood volume, and the decrease in wall thickness reduces the diffusion barrier. Thus, there will be an increase in the diffusion of inert gas from the tissues into the blood as we move along the arterial tree. This may result in the expansion of bubbles at the AHS within the arteries.

Methods and results:
An example of an arterial path was constructed from the aorta, leading to the common carotid artery, internal carotid artery, and anterior cerebral artery. Wall thickness is considered a diffusion barrier between well-mixed tissue and well-mixed blood, and is composed of the two inner layers of the artery, the intima and the media. The outer layer, the adventitia, which is rich in blood supply, is therefore assigned to the well-mixed tissue. Inert gas tension along the length of the arterial segment was calculated using the equation: $Px = P_T - (P_T - P0)e^{-(2\pi rD/WV)x}$, where Px, PT, and P0 are the gas tensions at distance x from the entrance to the vessel, in the surrounding tissue, and at the entrance to the vessel, respectively; r is the internal radius, W is wall thickness, V is blood flow, D is the diffusion coefficient, and x is the distance along the length of the vessel. This equation was used to calculate gas tension along the length of the arterial tree for a P_T of 500 kPa and a P0 of 101 kPa at the entrance to the aorta. The rate of inert gas loading increases with the reduction in vessel diameter, wall thickness and blood flow. Gas tension increased in the present example by 1% at the end of the anterior cerebral artery. However, when blood flow in the anterior cerebral artery is reduced to 10%, gas tension will increase by 44%. Further down along the arterial tree from the anterior cerebral artery, the reduction in flow and decrease in wall thickness may cause an increase in inert gas tension that will result in bubble expansion.

Conclusions:
The first phase of arterial bubble growth may begin during decompression, when the arterial blood is loaded with inert gas. Because the brain receives eight times the amount of arterial blood that flows to the spinal cord, more arterial bubbles should reach the brain. However, spinal DCI is over three times more frequent than cerebral DCI. The internal veins which drain the spinal cord do not have valves. It was also suggested that after decompression, spinal blood flow is reduced due to obstructions in the epidural vertebral veins. It is therefore possible that whereas cerebral circulation following a dive may increase, the reduction of spinal arterial blood flow could enhance the formation of arterial bubbles in the spinal cord. This might account for the increased risk of spinal as opposed to cerebral DCI.

O-18 COMPARISON OF DYSBARIC OSTEONECROSIS SEVERITY IN THE UW SHEEP MODEL AFTER A 24 HOUR DIVE AT 2.8 ATA FOLLOWED BY EITHER A 15-MIN, 1-H, 2-H OXYGEN PRE-BREATHES BEFORE DROPOUT DECOMPRESSION.

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Introduction:
After a provocative dive, bubble formation in fatty long bone marrow may lead to a bone compartment syndrome with bone and marrow ischemia and necrosis. We evaluated oxygen pre-breathes (15-min, 1-h, and 2-h) to determine which would be most likely to provoke dysbaric osteonecrosis (DON) and where DON would occur.

Methods:
Twelve adult female sheep (99 ± 14 kg SD) underwent dry chamber air exposure at 2.8 ATA for 24 h followed by oxygen (88-92%) pre-breathe (15-min, 1-h, and 2-h) before "dropout" decompression 0.9 ata/min). One month later, 99mTc-methylene diphosphonate (MDP) bone scans of radii and tibiae were used to detect "hot spots" of remodeling DON lesions. Alizarin complexone fluorochrome was injected IV to visualize sites of DON repair. Six weeks post "dropout" decompression; sheep underwent necropsy to observe DON pathology. Images of long bone gross pathology were taken. Using Scion Image software (Scion Corporation, Frederick, MD), we mapped the areal extent of alizarin complexone deposition as the index of DON severity. DON severity was compared by ANOVA.

Results:
Alizarin complexone deposition was greater in sheep experiencing 15-min O_2 pre-breathe dives than 1-h O_2 pre-breathe dives ($P<0.05$), and sheep DCS incidence was lowest in the 2- h oxygen pre-breathe group. Proximal radii accumulated more alizarin complexone in the 15-min O_2 pre-breathe group than in the 1-h group ($P<0.05$). The proximal tibia appeared most affected in the 2-h O_2 pre-breathe dive group ($P<0.05$).

Conclusions:
Brief 15-min O_2 pre-breathes dives show greater DON severity than 1-h and 2-h O_2 dives.
In humans, DON often may trigger secondary osteoarthritis. These findings indicate that even a 2-h O_2 pre-breathing did not prevent DON in decompressed sheep, but enabled "dropout" survival.

Key words: Dysbaric osteonecrosis, Oxygen pre-breathes

O-19 ACUTE HYPEROXIC EXPOSURE INDUCES THE EXPRESSION OF CCR5 IN CD4+ T-CELL COMPARTMENTS INDICATING MIGRATORY CAPACITY

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Introduction:
Migratory capacity of immune cells is known to be essential for a functional immune response. Abnormalities in expression of receptors involved in migration are important in the pathogenesis of autoimmune diseases such as granulomatosis with polyangiitis. Frequent exposure to hyperbaric oxygen showed immunosuppressive effects in animal studies. However little is known about similar effects in humans. The aim of this study was to assess changes in $CD4^+$ Tcell compartments regarding the expression of chemokine receptors following one acute hyperoxic exposure.

Methods:
Healthy male non-divers (n=14, mean age 25,80±3,25) were exposed to oxygen (30min, 280 kPa). Peripheral blood mononuclear cells (PBMC) were collected before and directly after the exposure. Further, PBMCs of healthy male non-divers (n=23, mean age 26,26±9,02) were collected and subdivided into two groups. PBMCs from group 1 were exposed to oxygen *in vitro* (30min 280 kPa). PBMCs from group 2 were kept under normoxic conditions *in vitro* (30min 20 kPa). Thereafter, the PBMCs were examined for expression of CD4, CD25 (IL-2Rα), FOXP3, CD195 (CCR5), CD197 (CCR7), CD162 (PSGL-1), CD62L (LECAM-1) and CD11a (LFA-1α) by flow cytometry

Results:
Following 30min of hyperoxic exposure effector T cells (T_E, $CD4^+CD25^+$Tcells) expressed lower levels of CD62L *ex vivo* and *in vitro.* Activated T cells (T_{act}, $CD4^+CD25^+$Tcells) expressed higher levels of CD162 only *ex vivo*. T_E, T_{act} and regulatory T cells (T_{reg}, $CD4^+CD25^{high}FOXP3^+$Tcells) presented an increased expression of CCR5 only *ex vivo*, whereas the expression of CCR7 was decreased *ex vivo* and *in vitro*.

Conclusions:
One hyperoxic exposure might lead to a shift in the Tcell compartments indicative of an elevated migratory capacity.

Keywords: Oxygen, Diving, Immune response, T-cell migration, Chemokine receptors

O-20 REAL-TIME UNDERWATER GLYCAEMIA MONITORING AND RECORDING DURING SCUBA DIVING IN YOUNG DIABETIC DIVERS

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Introduction:
The numbers of young divers with Type 1 Diabetes is steadily increasing. Despite the risk of hypoglycaemia, young diabetic divers can dive safely with a proper and careful management. The scope of this work is to investigate the possibility and the accuracy to use a real time continuous underwater blood glucose monitoring system in young diabetic divers.

Materials and Methods/
Ten adolescents, 12 to 18 years old, were monitored by a dedicated Continuous Glucose Monitor (CGM) hosted in a waterproof case, and a Subcutaneous Glucose Sensor (Dexcom G4). Data were recorded every 5 minutes during the dive and for 1 hour before and after the dive.
Diving was allowed only if pre-dive was within the 150-250 mg/dl range (or up to 300 but only if Ketones negative).
All the divers performed three 45-minute dive sessions in the Padova Y-40 swimming pool.
Some conventional signs and symbols were previously defined to check and communicate glycaemia values. Diving was stopped in cases of values higher than 300 mg/dl or lower than 150 mg/dl.
To validate the reliability of interstitial glycaemia measurement at increased ambient pressure, a comparison between capillary blood glucose (OneTouch® Verio®IQ) and subcutaneous interstitial glycaemia (Dexcom G4) was also effected.

Results:
We did not find any difference in blood glucose (BG) levels before and after the dives ($p<0.05$).
All divers showed a gradual BG decrease during diving and occasional borderline hypoglycaemia (<70mg/d), one dive was stopped because of reaching the sanctioned lower limits.
We did not find any statistically significant difference between CBG (Verio IQ) and CGM Dexom G4 data both in normobaric and hyperbaric conditions ($p<0.05$).

Discussion:
Continuous underwater real time monitoring systems may help young diabetic divers to prevent hypoglycaemia while diving. The currently available Sensors do assure accuracy also when used underwater.

O-21 INCIDENCE OF POST-DIVE BUBBLES AND DCS USING THE US NAVY REVISION 6 AIR DECOMPRESSION TABLES

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Introduction:
The Swedish Navy has implemented use of the US Navy Diving Manual Revision 6 air tables. A number of profiles were evaluated for use with SCUBA equipment using post-dive ultrasound bubble monitoring, and compared to data from the previously used air table to assess its safety.

Methods:
Seventy-two wet chamber dives were made by 28 divers from the Swedish Navy. Three profiles were dived over two days; first a 51 msw/10 min bottom time (bt) (deco stop at 6 msw/2 min), then around four hours later, a 24 msw/25 min bt (direct ascent). The following day, a 40 msw / 20 min bt dive (stop at 6 msw/7 min) completed the series. Post-dive, vascular bubbles were monitored using Doppler ultrasound (Kisman Masurel (KM) Scale) and 2D ultrasound (Eftedal Brubakk (EB) scale). Doppler measurements were made every 5 min for 30 min, then 15 min intervals until 2 h; 2D monitoring was discontinuous and checked for arterial bubbles. Bubble data from the 40 msw /20 min dives was compared with that from the previous air tables dives.

Results:
The dives produced a large amount of detectable vascular bubbles upon decompression; all three profiles produced a median maximum KM bubble grade of III or higher at both rest and flex. The median and maximum grade across all 72 dives was KM III. Two cases of limb DCS were treated with TT6 and there was one other borderline untreated case. Four subjects were given normobaric oxygen post-dive to reduce bubbling. Arterial bubbles, up to an EB grade of 3, were noted after four dives.

Discussion:
There was no significant difference between the bubble grades observed in the present series with those following dives with the previously used modified US Navy56 decompression table, and the estimated and observed risk of DCS also did not differ.

Key words: Decompression sickness, Venous gas emboli, Decompression table

O-25 EFFECTS OF HBO ON HEMORHEOLOGICAL PARAMETERS IN PATIENTS WITH AVASCULAR NECROSIS

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Introduction:
Red blood cell (RBC) aggregation and plasma viscosity are important hemorheological parameters and changes in these parameters may result with impairment in circulation. Studies about hyperbaric oxygen's (HBO) effects on hemorheological parameters are limited and generally conducted in vitro or on animals. The only study on humans did not reveal any significant changes in patients with various disorders. In the present study, hemorheological parameters were investigated in avascular necrosis (AVN) patients.

Methods:
Patients who were treated for AVN and did not have any chronic diseases were included. HBO was administered at 2.4 ATA for 120 minutes daily, five days a week. Blood samples were collected before the initial therapy and after the 20th session. Whole blood viscosity was measured using a cone/plate viscometer with a corrected hematocrit of 45%. RBC aggregation in both autologous plasma and dextran70 solution and deformability were measured using an ectacytometer (LORCA).

Results:
Results from ten patients (3 female, 7 male) are presented. Mean age of the patients was 45.2±13.2 years. There were no significant changes in hemotocrit values, corrected whole blood viscosity and RBC aggregation in both autologous plasma and Dextran70 solution before the first and after the 20th HBO sessions. RBC deformability was found significantly different only at high shear stresses. Plasma viscosity decreased significantly after the 20th session compared to initial values.

Discussion:
In comparison with the previous human study, only plasma viscosity and some RBC deformability values were found to change significantly. The results suggest that presence of a chronic disease may have a role in hemorheological parameter alterations; however, these are the preliminary results from an ongoing study. Results from a larger group and studies with different disorders will help to better define the effects of HBO on hemorheological parameters and to evaluate alterations.

O-26 HBO FOR THE TREATMENT OF HEMORRHAGIC CYSTITIS IN PATIENTS WITH ALLOGENEIC HEMATOPOIETIC STEM CELL TRANSPLANTATION

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Introduction:
Hemorrhagic cystitis (HC) is a common and major cause of morbidity in patients who undergo allogeneic hematopoietic stem cell transplantation (HSCT). Its incidence ranges from 7 to 52%, and its manifestations range from painless microscopic hematuria to severe bladder hemorrhage, leading to clot formation within the urinary tract and potential obstructive renal failure. Late-onset HC has been associated with reactivation of viruses, including polyoma BK and JC viruses, adenovirus types I and II, and cytomegalovirus. Hyperbaric oxygen (HBO) may benefit patients with BK virus (BKV) -associated HC after HSCT.

Objectives:
To retrospectively evaluate the the clinical resolution of hematuria in patients with HC after HSCT after treatment with HBO. To evaluate the difference in BKPyV DNA counts before and after HBO treatment.

Methods:
HBO therapy was started when patients showed grade 2-3 HC. Response to HBO was defined as macroscopic hematuria disappearance within the first 2 weeks; patients without improvement were categorized as having treatment failure. Patients received 100% oxygen in a hyperbaric chamber at 2.1 atmospheres for 90min 5 days a week. BKV was measured in urine as indicated by symptomatology and monitored by serial quantification every 3 days. Urinary tract BK load was measured by quantitative PCR.

Results:
A total of 27 patients (44% men, 56% women, ages ranging from 1-55 years) were studied. 78% were submitted to corticotherapy. 96.3% had viruria with BKV. The average time between HC diagnosis and beginning of HBO treatment was 12 days. 3 treatments had to be stopped due to complications. 90% of the patients had a complete, echographic and hematuria, response. The average BKV levels before treatment were $8.7 * 10^8$ and $2.1 * 10^5$ after the treatment.

Conclusion:
The treatment with HBO seems to be safe and effective and could be implemented for this kind of patients.

O-27 THE EFFECTS OF HYPERBARIC OXYGEN ON TRAUMATIC BRAIN INJURY PATIENTS SUFFERING FROM CHRONIC NEUROCOGNITIVE DELICTS - CORRELATION BETWEEN COGNITIVE FUNCTIONS AND BRAIN METABOLIC IMAGING

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Introduction:
Traumatic brain injury (TBI) is one of the leading causes of death and disability in the general population**.** Recent clinical studies in patients with chronic neurological impairments stemming from mild TBI have shown significant improvements after hyperbaric oxygen therapy (HBOT)**.** The aim of the current study was to evaluate the effect of HBOT in TBI patients suffering from chronic neurological deficits stemming from TBI of all severities (mild, moderate, and severe) in the largest cohort evaluated so far.

Methods:
A retrospective analysis was conducted on 154 patients suffering from chronic neurocognitive damage due to TBI, treated by HBOT between January 2008 and January 2017. Patients were included if they had pre- and post HBOT computerized cognitive evaluation. Pre- and Post HBOT brain SPECTs which were available for 100 patients were analyzed.

Results:
The average age was 42.7±14.6 years and 58.4% were males. All patients had documented traumatic brain injury 3 months to 33 years (mean 4.6±5.8, median 2.75 years) prior to HBOT. Sixty-nine (44.8%) had neurocognitive impairments due to mild TBI, 24 (15.6%) from moderate TBI and 61 (39.6%) from severe TBI. HBOT induced significant improvement in all of the cognitive domains where the global cognitive scores with a mean change of 4.6 ± 8.5 ($p<0.00001$). The most prominent improvement was in memory index, with 8.1 ±16.9 ($p<0.00001$) and attention with 6.8 ±16.5 ($p<0.0001$). The most striking changes in brain SPECTs were found in anterior cingulate (BA 24) and the post-central cortex (BA 5), the prefrontal areas (Ba 10,11, 46) and temporal areas (BA 20, BA 38, 36).

Conclusion:
HBOT induced significant cognitive improvements in patients post TBI of all severities who suffer from chronic deficits. Clinical improvement was well correlated with increased activity in relevant brain areas, with significantly higher increases in patients with larger cognitive improvements.

O-28 THE USE OF HBOT FOR PATIENTS SUFFERING FROM FIBROMYALGIA DUE TO MENTAL STRESS AS RESULT OF CHILD ABUSE.

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Introduction:
Fibromyalgia Syndrome (FMS) is a persistent debilitating disorder estimated to impair the quality of life of 2–4% of the population. FMS is an important representative example of central nervous system sensitization, associated with abnormal brain activity, that can be triggered by traumatic brain injury (TBI), nervous system infections (EBV, CMV) and severe persistence emotional stress. The goal of this study was to evaluate the effect of hyperbaric oxygen therapy (HBOT) on symptoms and brain activity in women suffering from FM triggered by childhood sexual abuse (CSA).

Methods:
The study included 30 females CSA survivors suffering from FMS, age 26-68 years. Patients were divided into 2 groups: treatment and control. The control group were treated according to the recurrent recommendation for FMS and the control group had 60 sessions of HBOT, 5 days per week, 100% oxygen at 2 ATA, 90 min each with 5 min air breaks every 20 min. All patients had clinical evaluation covering their FMS symptoms, quality of life and functional questionnaires, brain imaging (brain SPECT, perfusion MRI + DTI) and psychological testing. All tests were performed at baseline and after 3 months of HBOT or control.

Results:
HBOT induced significant improvement in clinical evaluated parameters as compared to the control. A significant improvement in tender points evaluation from 11.6±4.8 to 7.9±5.4 ($p=0.0002$) in the HBOT group, while the control had non-significant change from 11.3±3.9 to 11.5±4.7 ($p=0.57$). The Physical Function Assessment was significantly improved from 64.2±32.9 to 34.3±21.0 in the HBOT group and got non-significant worsening from 74.8±12.2 to 77.2±14.4 in the control ($p=0.29$). Quality of Life questionnaires was also improved from 38.3±23.1 to 58.7±25.7 in the HBOT group ($p=0.0001$) and had non-significant worsening in the control from 44.4±17.6 to 37.2±18.4 in the control ($P=0.009$). With regards to brain imaging the metabolism in Brodman Areas 37L, 45L, 8L was increased and in Brodman Area 25R, 23L, 38L 28R it was reduced.

Conclusions:
HBOT can induce neuroplasticity, relieve pain, FMS related symptoms and improve quality of life of fibromyalgia patients in whom the syndrome was triggered by CSA. The metabolic brain imaging indicates that CSA related FMS represent a unique group that is different from other types of fibromyalgia and should probably referred differently.

O-29 PNEUMATOSIS INTESTINALIS NON-RESPONDER TO HBOT: A SUCCESSFUL CASE REPORT OF A PATIENT TREATED BY HYPERBARIC HELIOX.

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Introduction:
Pneumatosis intestinalis is a rare condition defined as "gas deposits in the intestinal walls", whose etiology is not always clear.
There are two kinds of pneumatosis intestinalis: Primary (15%), which is usually idiopathic and asymptomatic, and Secondary (85%), which is often caused by cases of intestinal ischemias, post-traumatic events, chronic phlogosis or infections, autoimmune diseases, chronic pulmonary diseases etc. Pneumatosis seems to be caused by the interaction of different factors, such as the integrity of the intestinal mucosa, the endoluminal pressure, the altered intestinal bacterial flora and the quantity of endoluminal gas. It is clinically manifested by chronic diarrhea, abdominal pain, bleeding, swelling and it can also cause major problems of reabsorption. The treatment of the asymptomatic secondary forms can be medical or surgical but in several cases this approach may turn out to be ineffective. The hyperbaric therapy can be a further therapeutic option (Consensus Conference 2016 – Lille F – level 2^{nd} B).

Methods:
Our colleagues from the University Hospital of Bologna of the Gastroenterology Department sent us a 66-year-old woman affected by secondary pneumatosis intestinalis (diagnosed by CT scan) and non-responder to the prescribed medical therapies: the patient lamented modest abdominal pain with profuse diarrhea, accentuated abdominal bloating and a clinically evident diagnosis of malabsorption disorders. Her medical history reveals a severe stage of COPD, sclerodermia and previous (but recent) suprainfection caused by *Clostridium difficile*. In the period 2014-2016 the patient was submitted to 5 cycles of HBOT made of 20 sessions of 90 minutes each at 2.5 ATA. After each cycle the patient reported a minimal and moderate improvement of the symptomatology, while the CT scan showed a stationary radiological picture. For this reason, in May 2016 the patient was recommended a treatment of 15 sessions of 90 minutes each at 2.5 ATA with Heliox 50/50 and five days per week.

Results:
One month after the therapy with Heliox the patient had already shown a significant clinical improvement (no more diarrhea, no more bloating, initial increase of the body weight and a great improvement of all the above-mentioned symptoms). The follow-up CT scan check showed a real reduction of the pneumatosis intestinalis.

Discussion:
In literature Heliox is considered to be better than standard HBOT as therapeutic mixture. The recommended protocol is the COMEX 30. Besides confirming the usefulness of Heliox as therapeutic mixture for this condition and thus stimulating the basic research on this gas, the clinical result of this case report demonstrates that even a simpler treatment in terms of session duration and pressure (Cx 30 vs standard session) can equally bring clinical benefits. Last but not least, its organization looks simpler than the table Comex 30 in terms of logistics and economics. Further studies and research need to be carried out to prove this statement; in this way this may be considered a valid therapeutic strategy for this rare pathological condition.

O-30 HYPERBARIC OXYGEN THERAPY CAN MODULATE IMMUNE SYSTEM REGULATION OF HEALTHY AGING HUMAN VOLUNTEERS

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Background:
Over the past years hyperbaric oxygen therapy (HBOT) has been used in a wide variety of medical conditions. In addition to improving tissue hypoxia, there is cumulative evidence in diseased conditions that HBOT may have anti-inflammatory effects. However, there is only scars data regarding the effect of HBOT on the immune system under normal healthy conditions. The aim of this study was to investigate the direct effect of HBOT on the immune system on healthy stable individuals.

Methods: Twelve elderly (age>65 years) healthy subjects were exposed to 60 hyperbaric sessions of 100% oxygen at 2 ATA, 5 days a week for 90 minutes each with air breaks every 20 minutes. Freshly collected peripheral blood mononuclear cells (PBMC) were isolated by gradient-density at several time points: pre HBOT, after 30 session and after 60 sessions. Immunophenotyping of T regulatory cells (Treg), Hematopoietic/Mesenchymal Stem Cells (HSC/MSC, respectively) and T cell senescence were determined by Flow cytometry.

Results:
With regards to T cells, both Treg helper cells CD4+/CD25+ and Treg cytotoxic cells CD8+/CD25+ were significantly increased during the first 30 treatments. Moreover, analysis of T cells lacking CD28 as a hallmark of senescence showed gradually decrease with HBOT. HBOT induced significant increase in hematopoietic/progenitor stem cells CD34+/CD45-. Interestingly, circulating mesenchymal/progenitor stem cells CD34-/CD45- were also significantly increased.

Conclusions:
HBOT induced upregulation of T regulatory cells. This effect holds promise for further investigation of the use of HBOT in different autoimmune disease where a reset of the over activated immune system is needed. In addition, for the first time in humans, it was demonstrated that HBOT induces, in addition to hematopoietic stem cells, proliferation and increased blood concentration of mesenchymal stem cells.

Keywords: Immune system; HBOT; Hematopoietic Stem Cells; Mesenchymal Stem Cells; T regulatory cells

O-33 EFFECTS OF KETOGENIC DIET IN DIVERS BREATHING ENRICHED AIR NITROX

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Introduction:
Overweight divers face a challenging activity such as immersions, starting from a higher levels of circulating cytokines and oxidative stress. Ketogenic Diet (KD) is described as effective in weight loss, in countering inflammation and oxidative stress, and used in the control of drug-refractory seizures. This pilot study aimed to investigate if KD may protect divers from oxidative stress and inflammation during immersion.

Methods:
Blood and urine samples from six overweight divers were obtained
a) before (CTRL) and after a dive breathing Enriched Air Nitrox and performing light underwater exercise (NTRX),
b) after a dive (same conditions) performed after 7 days of KD (K-NTRX).
We measured urinary 8-isoprostane and 8-OH-2-deoxyguanosine evaluating lipids peroxidation and DNA oxidative damages. Plasmatic IL-1β, IL-6 and TNF-α levels were measured to investigate the inflammatory status.

Results:
KD was successful for weight loss (3.20 ± 1.31Kgs) and seemed to dampen lipids peroxidation and inflammatory biomarkers production in response to EAN-diving. Indeed, Levels of 8-isoprostane, IL-1β, IL-6 at K-NTRX dive were similar to those measured at the baseline.

Conclusions:
In conclusion, short-term KD seems to be effective in weight loss and protective towards lipids peroxidation, and inflammatory status triggered by diving.

O-34 PAEDIATRIC SCUBA-RELATED MORBIDITY AT US EMERGENCY DEPARTMENTS

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Purpose:
Scuba diving is a popular recreational pursuit enjoyed by millions of U.S. divers. The burden of scuba injury among children is unknown. This study investigated scuba-related Emergency Department (ED) presentations by children in the US.

Methods:
The National Electronic Surveillance System (NEISS) was searched for scuba diving injuries 1998-2015. Identified data met U.S. Consumer Product Safety Commission (CPSC) criteria for reliability, I.E. coefficient of variation <0.3, >20 actual cases and >1,200 estimated (weighted) cases nationally. Confidence intervals were estimated by Monte Carlo resampling with replacement.

Results:
In the US there were an estimated 13.5 million ED presentations annually (95% CI 13.1, 13.8 million), with 1,401 (95% CI 646, 2,156) for scuba-related injuries (0.01%), 76 of those (95% CI 0, 212) per year (0.0005%) in paediatric patients. Over the study period a weighted estimate total of 1362 children presented with scuba-related injuries (95% CI 0, 2,924). Where recorded, almost all occurred at places of recreation, not the home. Of the 37 actual cases, 24 (65%) were male, 13 (35%) female, median age was 14 (range 2-17) and the most common injuries were barotrauma (most commonly to the ears but also to the eyes and lungs), lacerations, or musculoskeletal strains. The majority (33/37, 89%) were treated and released, or examined and released without treatment. The remaining four were admitted to hospital or held for observation.

Conclusions:
ED presentations for scuba-related injuries among children are extremely rare. In the US only one out of every 10,000 ED presentations is due to a scuba–related injury, and only one of every 200,000 ED presentations are for scuba-related injuries in children. The most common paediatric scuba-related injuries seen at the ED were typical of those also seen in adults. The majority of children presenting at the ED with scuba-related injuries were treated and released.

Keywords: Barotrauma, Emergency Department, NEISS.

O-35 INNER EAR DECOMPRESSION SICKNESS(IEDCS) OR INNER EAR BAROTRAUMA(IEBT): A CASE REPORT

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Background:I
EDCS is an incompletely understood and increasingly recognized condition in compressed-air divers. IEBT have similar symptoms.

Patient / Method:
We report a case of 42 years old professional diver. After one week off for sinusitis, he dived for 25 min/24m to test the old compressor they had just cleaned from rust and oil.
Second dive was 50min/32m after a 45min break. He felt stomach-ache at the boat with dizziness, poor co-ordination and gait, nausea, vomiting, spontaneously right beating rotational vertigo.
He was refered to our hyperbaric chamber for DCS. In limited physical examination, because of vomiting, there were cutis marmorata and nystagmus confirming DCS.
He was immediately compressed to USNTT6, then was converted to TT6A.
Cutis marmorata was better. He was hospitalised for further examination and treatment.
On audiometry total (120 dB) sensorineural hearing loss (SNHL) was found at right ear.
MR findings revealed sinusitis and mastoiditis.
He was better with methylprednisolone, metoclopramide and piracetam.
Dix Hallpike maneuver was positive at the right side and he tolerated Epley repositioning maneuver at the second day.
No patent ductus arteriosus (PDA) or patent foramen ovale (PFO) was detected with echocardiography.

Results:
30 sessions of HBOT revealed no recovery on SNHL. Explorative tympanotomy was performed 30 days after DCS because of the upper airway infection and then herpes labialis. Both oval and round window fistulas were detected and repaired with fat tissue graft. There was no change on pure tone audiogram but dizziness and balance disorder quite decreased.

Discussion:
IEBT and IEDCS are difficult differential diagnosis. Ear pain, hearing loss, horizontal-rotatory nystagmus, vertigo, vomiting are similar in both IEDCS or IEBT. Leucocytosis, stomach-ache after diving, cutis marmorata and mobile pain reveals DCS. Breathing air was not clean and he had had an infection so the case was complicated. The final diagnosis was combined DCS and IEBT.

O-36 DECOMPRESSIVE ILLNESS TREATED IN GOZO 2009 – 2016

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Introduction:
Diving with SCUBA in Gozo is very popular as Gozo forms part of the Maltese archipelago in the middle of the Mediterranean Sea.
The aim of our study is to report the incidence, diver characteristics and symptomatology of decompression illness in Gozo between the year 2009 and 2016.

Method:
The local data was collected from the records held at the Hyperbaric Unit at the Gozo General Hospital. Data was collected from the year 2009, which was the year the unit was fully functional, till 2016. All cases of decompression illness treated during this period have been recorded and medical records were reviewed and data extracted on the age, gender, type of diving, initial type of hyperbaric treatment, DCI symptoms and immediate outcome. Trend in annual case numbers was evaluated using run chart analysis and Spearman's correlation.
Data was reported anonymously.

Results:
The average number of divers treated for DCI in Gozo annually was 14.
27.2% were German, 26.3% British, 14.9% French and 7.9% Belgian. The other 23.7% were Greek, Maltese, Dutch, Finish, Italian, Croatian, Spanish, Irish, Austrian, Lithuanian, Romanian, Polish, American, Swedish, and French-Swiss.
The average age was 42.4 years and the average depth was 32.95msw.
The most common symptoms were pain (49.1%), nausea/vomiting (43.9%) and dizziness/vertigo (37.7%) followed by paraesthesia (31.6%), skin rash (23.7%), weakness (19.3%), visual disturbance (16.7%) and cerebellar signs (14.0%).

Conclusion:
The divers in their great majority are foreigners and following treatment they usually leave the island. We observed a 3.5-fold increase in DCI cases since the period of 1990–1999. Divers with residual symptoms after the initial treatment were offered follow up treatment until a plateau in resolution of symptoms was reached.

O-37 DESCRIPTION OF 4 CONSECUTIVE CASES OF HYPEROXIC CRISIS IN THE HYPERBARIC CENTER IN ANCUD HOSPITAL, CHILE.

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Hospital Ancud, Ancud, Chile [(1)]

Introduction:
The hyperoxic crises (HC) are an infrequent difficulty in the hyperbaric treatments.

Objective:
Describe the HC presented in the care unit between April of 2015 and December of 2016.

Methods:
Clinical records were checked, the health professionals who applied the treatment were interviewed.

Results:
- 4 patients presented HC (3.3%)
- None of them presents chronic pathologies, use of medicines or drugs.
- 3 of them had antecedents of non-neurological decompression sickness (DS).
- One of them had familial antecedents of epilepsy (sister).
- None of them presented cerebral DS symptoms.
- All of them showed leukocytosis in the admission.
- The use of normobaric oxygen previous to the hyperbaric treatment varied between 2 and 5 hours.

All the patients presented HC at different times: the first at the end of the third series of Oxygen (55 minutes 2.8 ATA), the second at the end of the second series of oxygen (38 minutes 2.8 ATA), the third in the first recess after 20 minutes applying oxygen with 2.8 ATA, the fourth after been exposed 40 minutes to 2.8 ATA, and then presented HC again after 15 minutes of ascent to 1.9 ATA (with a pressure of 2.35 ATA).
Three of them presented as prodrome an intense choking sensation, the other presented hearing loss at both sides and shaking, all followed with a convulsive tonic clonic self-limited crisis. All of them treated with 2 mg of intravenous lorazepam and in one case the dose was doubled.

Conclusion:
The group presented a high incidence rate of hyperoxic crisis with low exposition of hyperbaric oxygen, without necessity to relate it with studied factors except than all of them presented leukocytosis.
Familial antecedent of epilepsy seems to be related to occurrence of HC.

Key words: Hyperoxic crisis, Leukocytosis, Lorazepam, Epilepsy.

O-38 EFFECT OF HYPERBARIC OXYGEN ON EXTRACTED LYMPHOCYTES IN COMBAT SWIMMERS COMPARED TO ENDURANCE ATHLETES

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Introduction/Objectives:
We have previously shown in Navy divers that increased oxygen partial pressure affects blood cells in various ways, including DNA-fragmentation, alteration of cell subsets and induction of inflammatory response. Increased oxygen uptake (VO_2max) is also common during endurance training. We hypothesise that excess production of reactive oxygen species (ROS) under hyperbaric oxygen exposure ex vivo leads to similar adaptation mechanisms in peripheral blood mononuclear cells (PBMCs) of combat swimmers and athletes with differential physical activity.

Methods:
54 healthy male subjects (26.8±5.5 years, BMI 24.3±2.2) were recruited and grouped as follows: combat swimmers during strenuous in water training (*O_2-divers*), subjects with high physical activity (*athletes*), and subjects with lower physical activity (*controls*). PBMCs were extracted from blood samples and exposed to 4 bars of O_2 for 4 hours. We assessed DNA-fragmentation using single cell gel electrophoresis, apoptosis (Annexin V) and immune cell composition (CD3+, CD4+, CD8+, CD19+, CD56+) using flow cytometry and gene expression of oxidative stress markers (HO-1, NQ01), pro- (IL-1ß, IL-6, IL-12, IFN-y) and anti-inflammatory cytokines (IL-10, TGF-ß1) with rtPCR.

Results:
Basal differences in the O_2-divers were found in IL-1ß, TGF-ß1, and HO-1-expression patterns compared to the other groups. After hyperoxia IL-12 and NQ01 expression were significantly altered, while athletes showed a reduction in CD8+ cells. DNA-fragmentation was evident, but showed no significant differences between the three groups. No increased apoptosis induction was found in either group before, after and one day after oxygenation.

Discussion/Conclusion:
Our results suggest a long-term adaptation and complex regulatory pro- and anti-inflammatory responses in the groups repeatedly exposed to ROS (athletes and O_2-divers), however, there seems to be a distinct difference in the underlying mechanisms. An involvement of mitochondrial function (NQ01) and shift in cell subsets will have to be examined in future experiments.

Key words: VO_2max, oxidative stress, DNA-fragmentation, inflammation, apoptosis

O-39 DECOMPRESSION ILLNESS IN EXTREME BREATH-HOLD DIVE (TARAVANA SYNDROME) - A CASE REPORT

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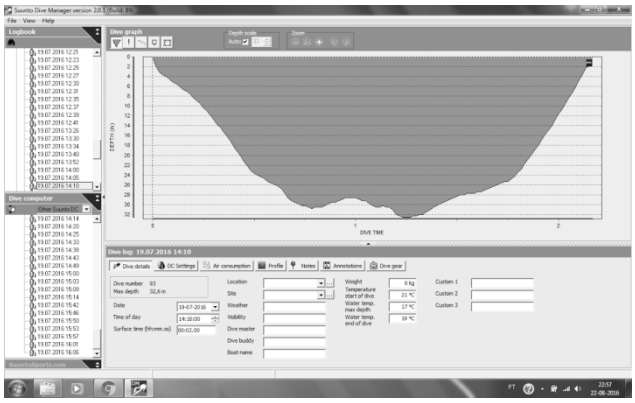
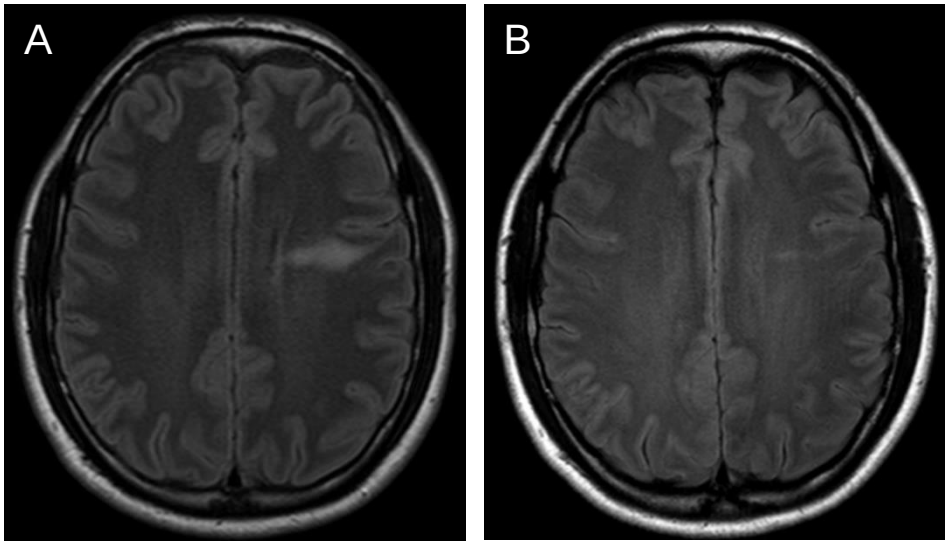
Introduction:
Decompression Illness (DCI) following breath-hold (BH) diving is extremely rare. Repetitive BH diving can lead to accumulation of Nitrogen in blood and tissues, which may cause neurological manifestations of DCI. This condition, called *Taravana Syndrome*, has been initially described in the late 1950's. Magnetic resonance imaging (MRI) is important to detect neurological involvement. Recompression is required when neurologic symptoms develop. We report a clinical case of DCI, in extreme breath-hold diving, treated successfully in our center.

Methods:
A healthy 39-years-old man developed neurological symptoms after extreme breath-hold diving. The diver reported having performed 20 to 30 breath-hold dives, with a depth between 29 to 32 meters, for five hours, without surface intervals. The total time of each dive was 2 to 2.5minutes (Figure 1). The descents were carried out with the help of an underwater propulsion vehicle "Apollo Av 2".



A few minutes after finishing diving he developed transient expressive aphasia and headache. Because of maintenance of headache he went to hospital emergency room, 48 hours after initial symptoms. Brain MRI showed a linear T2/ FLAIR hypertense white matter left frontal lesion, spearing the sub-cortical U-fibers, without restricted diffusion and with no contrast enhancement nor mass effect (Figure 2-A). Echocardiogram showed patent foramen ovale. The patient underwent hyperbaric oxygen therapy (HBOT). After initial emergency treatment (table 6) he completed 5 routine sessions (2,5 ATA) on the following days.

Results: After treatment, his clinical condition significantly improved. At one month follow-up, the lesion had regressed almost completely (Figure 2-B) and he remained asymptomatic.



Discussion:
Breath-hold divers and physicians must be aware of the possibility of DCI after repetitive BH diving. Appropriate diagnostic and therapeutic measures should be taken, when suspicion of DCI is present.

Key words: Breath-hold diving, Taravana syndrome, Magnetic resonance imaging, Hyperbaric oxygen therapy.

O-40 EFFICACY OF EARLY TREATMENT OF DECOMPRESSION SICKNESS IN AN ON-SITE FACILITY VS. DELAYED TREATMENT OF DECOMPRESSION SICKNESS IN AN OFF-SITE FACILITY.

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Background:
Decompression sickness (DCS) is a well known cause of physical impairment in divers.
The benefit of early treatment of severe cases of DCS is well documented and widely practiced.
Nevertheless, most cases of DCS present as mild symptoms of joint pain (DCS TYPE I), or in form of paresthesia's usually involving the extremities to which the authors refer to as DCS TYPE II mild (DCS TYPE IIm).
Recent data shows the efficacy of delayed treatment of mild DCS as much as 7 days after symptom development.
Our goal was to compare clinical results of early on site treatment of mild DCS to delayed treatment of mild DCS off-site.

Methods:
Retrospective analysis of treatments of DCS between the years 2016-2015 was obtained from an on-site hyperbaric medical facility in Eilat (Israel) and compared to parallel data obtained from an off-site hyperbaric medical facility in Tel-Aviv (Israel). Inclusion criteria were: diagnosis of DCS with at least one active symptom at the start of recompression, usage of treatment tables USN Table 5 or USN Table 6. Excluded were: all cases of critical care patients, use of other treatment tables than USN Table 5 or USN Table 6 or full recovery prior to initiation of recompression therapy.

Results:
Of 53 cases of DCS which were included in our analysis. A total of 24 patients concluded treatment in the on-site facility. 23 patients concluded recompression therapy with a full resolution of symptoms, one patient needed 1 tailing therapy of hyperbaric oxygen (HBOT) to fully recover. All patients were discharged with a full resolution of symptoms. Average time from presentation of symptoms to the start of recompression was 7.8 hours.
In the off-site facility, 29 patients concluded recompression therapy. 17 patients concluded recompression therapy with a full resolution of symptoms. 12 patients went on to receive 1-5 tailing therapies of HBOT. Of these 12 patients, eight were discharged with a full resolution of symptoms. four patients concluded recompression and tailing HBOT therapy without a full resolution of symptoms. Three patients had improved and one patient remained unchanged after completion of the tailing sessions. Average time from presentation of symptoms to the start or recompression was 42.2 hours.

Conclusions:
Although late recompression therapy in off-site hyperbaric medical facilities has been shown to have efficacy in treating DCS TYPE I and DCS TYPE II in sick divers, our conclusion is that the gold standard should continue to be rapid on site treatment of DCS in all divers if available.

P-01 THE EFFECT OF HYPERBARIC OXYGEN THERAPY ON RHABDOMYOLYSIS-INDUCED MYOGLOBINURIC ACUTE RENAL FAILURE IN RATS

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Purpose:
The aim of this study was to investigate the effects of hyperbaric oxygen (HBO) therapy on renal functions, oxidative stress, and histopathological changes in rat kidneys after myoglobinuric acute renal failure (MARF).

Methods:
Wistar-Albino rats were divided into 3 groups: control (n=4), MARF (n=8), MARF+HBO (n=8). MARF was induced by intramuscular glycerol (50%, 8 ml/kg) injection. Saline (8 ml/kg) was injected into the hind limb of the animals in the control group. Animals in the MARF+HBO group received two sessions of HBO therapy (90 min at 2.5 atm) 2 and 18 hours after glycerol injection. Serum and tissue samples were taken at 24 hours.

Results: Serum urea and creatinine levels significantly increased in the MARF and MARF+HBO groups, but they were similar in MARF and MARF+HBO groups. Creatinine kinase (CK) also increased in the MARF group. HBO therapy slightly but not significantly reduced CK level. Oxidative stress parameters were similar among all groups. Histological renal injury score was similar in MARF and MARF+HBO groups. HO-1 level, determined by immunohistochemistry, was significantly higher in MARF and MARF+HBO groups, compared to the control group. Although HO-1 level in MARF+HBO group was higher than MARF group, it was not statistically significant.

Conclusion:
HBO therapy did not reduce the renal injury related to MARF in this experimental model. Further studies are needed to show the effect of HBO treatment on MARF.

Key words: Kidney, Crush injury, Hyperbaric oxygen, Rhabdomyolysis

P-02 HYPERBARIC OXYGEN THERAPY FOR SPINAL CORD ISCHEMIA AFTER THORACOABDOMINAL AORTIC ANEURYSM REPAIR

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Introduction:
Repair of thoraco-abdominal aortic aneurysm (TAAA) is a complex surgery, with a high rate of debilitating postoperative complications, including spinal cord injury. Data from the literature report a rate of spinal cord deficits post-TAAA repair of approximately 10%, with permanent paraplegia in 2.9% and permanent paraparesis in 2.4% of the patients. Rescue therapies in spinal cord injury post TAAA repair traditionally include optimization of spinal cord perfusion and oxygen delivery by mean arterial pressure augmentation (> 90 mmHg), cerebrospinal fluid (CSF) pressure decrease by CSF drainage, and preservation of adequate hemoglobin concentration (> 100 g/l). Hyperbaric oxygen therapy (HBOT) has been described in several case reports as a part of the multimodal therapy for spinal cord ischemia.

Objectives:
To describe our experience with HBOT as an adjunct rescue treatment for patients with severe spinal cord injury post-TAAAs repair and lack of response to the traditional medical management.

Methods: After the University Health Network Research Ethics Board approval, we performed a retrospective review of the clinical details and outcomes of all post-TAAA repair patients that developed spinal cord injury with severe motor deficit and were treated with HBOT at the Toronto General Hospital since 2013.

Results:
A total of seven patients with spinal cord injury after TAAA repair were treated with HBOT in addition to traditional rescue therapies. Five patients showed variable degrees of recovery, with two patients showing full recovery. One patient developed oxygen induced seizure required intravenous midazolam administration. No other HBOT related complications were noted.

Discussion:
We described successful use of HBOT and its effect on neurological outcome in patients who developed spinal cord injury after TAAA repair. Further prospective research is needed to understand the role, efficacy, benefits and risks of HBOT in this setting.

Key words: Hyperbaric Oxygen, Spinal Cord Ischemia, Thoraco-abdominal Aneurysm Repair

P-03 HYPERBARIC OXYGEN THERAPY IN A ASA I VICTIM WITH AN POST HANGING SUICIDE ATTEMPT ANOXIC ENCEPHALOPATHY

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Introduction:
Azores has the fourth highest suicide rate in Portugal, hanging is the most used method in our country. Post anoxic encephalopathy is a known complication of failed hanging suicide attempts.

Methods:
A young male, ASA I, was found hanging from a rope after a suicide attempt, brought to the Emergency department by the prehospital team according to the trauma protocol with a GCS of 6 (E1V1M4) and a SpO2 of 94%. On arrival, the patient was intubated and sedated. ABG with 7.19 pH and serum lactate 12.57 mmol/L; the neurologic exam revealed bilateral fixed mydriasis, bilateral Babinski sign and GCS of 6 with decerebration movements. Toxicological screening was negative for abuse substances. He was admitted to the ICU after trepanation and placement of intracranial pressure (ICP) sensor. Our unit was contacted 24h after patient admission and started HBOT following the USNTT9mod and completed 3 HBOT sessions on the first 36 hours after contact, 60 hours after hospital admission.

Results:
He was kept under mechanical ventilation and sedation with normal ICPs on the ICU, with slow progressive improvement. On the 5th day an EEG was taken with the patient sedated, showing a residual post anoxic encephalopathy wave pattern. Later that day, the patient was extubated. On the 8th day, he was discharged from the ICU to a Psychiatry Ward, with a GCS of 15; an anterograde amnesia after the event and no neurological focal deficits.

Discussion:
This was the first post anoxic encephalopathy case treated in the unit, with favourable clinical evolution in spite of delayed institution of HBOT. This case raised awareness of the clinical staff for early HBOT implementation, and discussion was installed about the relevance of a delayed institution of HBOT on ASA I patients.

Key words: Hyperbaric Oxygen Therapy; Post Anoxic Encephalopathy; Hanging suicide attempt

P-04 WOUND HEALING IN SYSTEMIC AUTOIMMUNE DISEASES. HYPERBARIC OXYGEN THERAPY COULD HELP? FIVE CASE REPORTS.

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Centro Iperbarico Srl, Centro Iperbarico Bologna, Bologna, Italia [(1)]

Introduction:
Chronic nonhealing ulcers can complicate the clinical situation in patients suffering from Systemic Autoimmune Diseases, like Rheumatoid Arthritis or Vasculitis. We investigated the role of the Hyperbaric Oxygen Therapy (HBOT) to promote the healing process in these types of ulcers.

Methods:
We reported five consecutive cases of patients with chronic nonhealing legs ulcers treated with 30 sessions of HBOT 2.5 absolute atmosphere(ATA) and advanced dressing, with histological and serological diagnosis of systemic autoimmune diseases.
All patients were female (age range 38-87) affected by Rheumatoid Arthritis, Vasculitis Cryoglobulinemic HCV related, Vasculitis Cryoglobulinemic HCV negative, Small Vessels Vasculitis and Systemic Lupus Erythematosus, respectively.
All patients were in treatment with immunosuppressive therapies for at least 6 months with no improvement of ulcers.

Results:
The baseline ulcer areas were decreased at the end of HBOT therapy, three patients demonstrated complete healing, two had partial healing. None of the patients had any side-effects related to the HBOT.

Conclusions:
HBOT improves ulcer healing rates and could be a safe, coadjuvant approach in the treatment strategy of chronic nonhealing ulcers in patients suffering from systemic autoimmune diseases.

Key words: Leg ulcer, Systemic Autoimmune Diseases, Hyperbaric Oxygen Therapy

P-05 EFFECT OF A SINGLE HYPERBARIC OXYGEN THERAPY ON PULMONARY FUNCTION IN PATIENTS WITH SYSTEMIC SCLEROSIS ULCERS

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Introduction:
Application of hyperbaric oxygen therapy (HBOT) in systemic sclerosis (SSc) ulcers raises concerns that patient`s impaired pulmonary function may worsen. Aim of this study is to evaluate the possible acute impact of a single hyperbaric chamber exposure on pulmonary function in patients with SSc ulcers.

Methods:
We studied a group of 20 patients, 85% females, with SSc related ulcers, treated in our facility. Average age was 56.15±12.75 years. All received HBOT at 2.2 ATA for 70 minutes, daily. Pulmonary function tests (PFTs), were performed before and 15 minutes after a single chamber exposure, at the beginning of HBOT protocol. Student's paired t test was used in the data analysis.

Results:
We did not find statistically significant difference in PFTs after a single chamber exposure, in any of the studied variables. Mean vital capacity (VC 3.25±0.87 vs. 3.23±0.9; p=0.40) and the mean forced vital capacity (FVC 3.21±0.95 vs. 3.23±0.95; p= 0.25), were similar before and after the treatment. We only found that mean forced expiratory flow (FEF 25-75) was lower after HBOT (2.72±0.76 vs. 2.18 ±0.69), but the difference did not reach statistical significance (p=0.069). This fact may implicate some acute reaction of small airways.

Conclusion:
The first results of this study do not show acute deterioration of pulmonary function in our group of patients. It is necessary to follow a larger group of patients, include a control group, repeat the PFTs at the end of HBOT protocols and evaluate possible acute effects of HBOT on transfer factor for CO, as well. If the results are favorable, HBOT may be considered as an effective and relatively safe option for SSc related ulcers.

Key words: Pulmonary Function, Hyperbaric Oxygenation, Systemic Sclerosis, Pulmonary Fibrosis.

P-06 A CLINICAL TRIAL TO ASSESS WOUND TISSUE OXYGENATION WITH NIRS 2D IMAGING IN CHRONIC VENOUS ULCERS TREATED WITH HBO: PRELIMINARY RESULTS.

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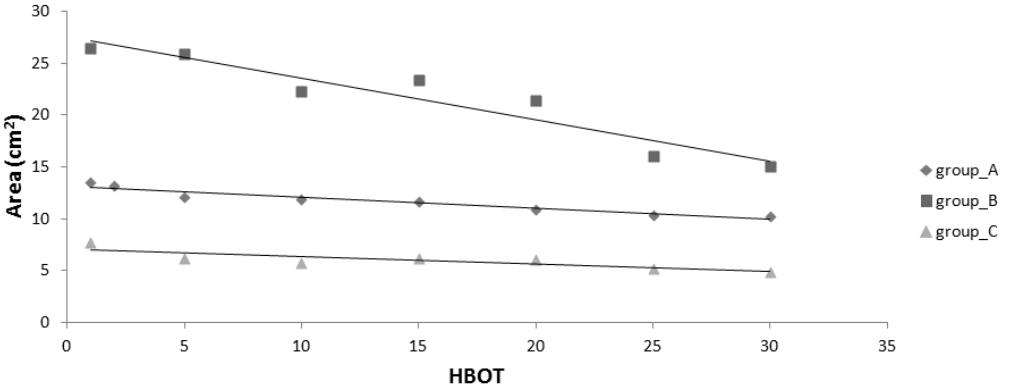
Introduction:
Hyperbaric oxygen therapy (HBOT) is used to reduce the healing time of chronic venous ulcers. The aim of this study is to evaluate whether the measurement of the local changes in oxygen saturation (StO_2) of the ulcer, obtained with Near Infrared Spectroscopy (NIRS) imaging, can prove the efficacy of HBOT.

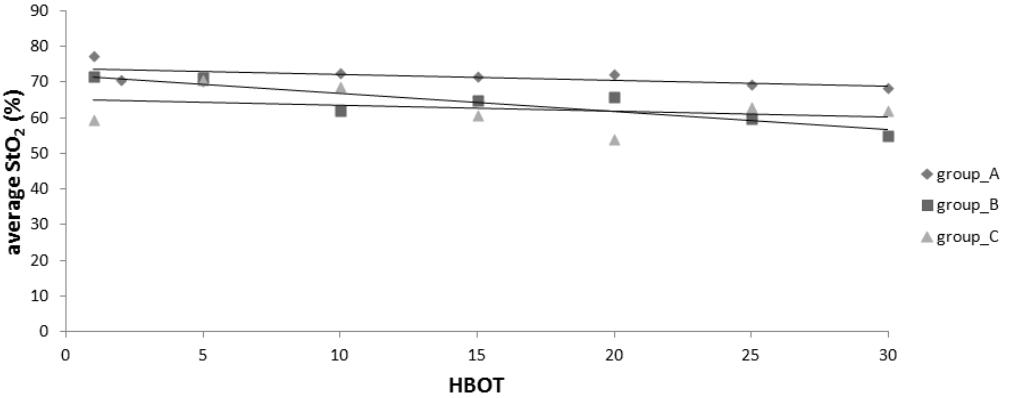
Methods:
17 patients were enrolled and divided into three groups: group A: 2 HBOT/day (6 patients); group B: 1 HBOT/day (5 patients); group C: no HBOT (6 patients).
The NIRS images were acquired before and after the HBOT (for a total of 30 treatment). The ulcer area and the local StO_2 were estimated from images and compared statistically to assess differences in the healing process in relation to the treatment.

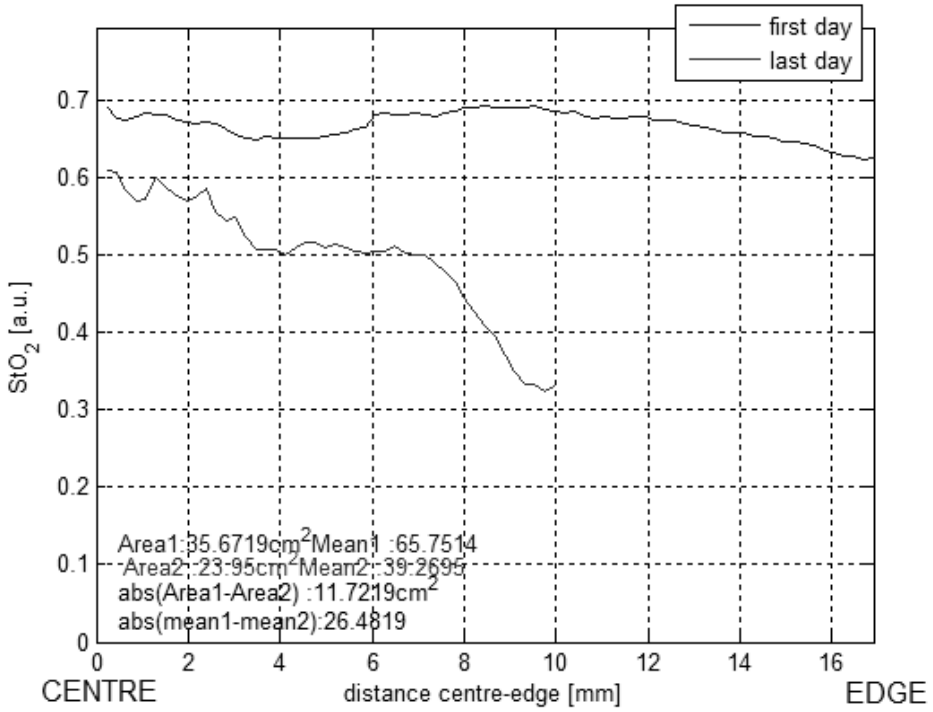
Results:
Results show that:
- the ulcer area after the last HBOT is less than the area at the first day of visit for all groups: the total area reduction is greater for the group B;
- the average StO_2 after the last HBOT is less than the average StO_2 at the first day of visit for all groups: the total reduction of StO_2 is greater for the group B;
- patients in group B, relatively to local StO_2 as a function of the ulcer geometry (distance centre-edges), have a greater difference between the first and last day of therapy on the edges (with respect to the group A).

Discussion:
The results indicate a possible use of local StO_2 from NIRS images to demonstrate the efficacy of the treatment of chronic venous ulcers with HBOT. The information about the local StO_2 as a function of the ulcer geometry could be useful to make a prediction about the healing time and to compare different HBOT protocols. The study is underway with the enrollment of new patients to have more significant results.

Key words: Chronic Venous Ulcer, HBO Therapy, Local Tissue Oxygenation, NIRS


Area (cm²)
HBOT
group_A
group_B
group_C


average StO2 (%)
HBOT
group_A
group_B
group_C


first day
last day
StO2 [a.u.]
Area1: 35.6719cm2 Mean1 : 65.7514
Area2: 23.95cm2 Mean2: 39.2695
abs(Area1-Area2) :11.7219cm2
abs(mean1-mean2):26.4819
CENTRE
distance centre-edge [mm]
EDGE

P-07 THE PERSPECTIVES AND ATTITUDES OF PLASTIC SURGEONS TOWARDS HYPERBARIC OXYGEN THERAPY: A GLOBAL SURVEY

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Background:
Hyperbaric oxygen therapy (HBO) is frequently used among various disciplines. We evaluated the perspectives and attitudes of plastic surgeons towards HBO therapy through an online survey.

Methods:
We prepared specific questions aimed at identifying the expertise of the participants, their perspectives and finally their practice towards HBO therapy. The questionnaire was tested on a minority of the participants and relevant changes were made prior to its final distribution through an online survey tool. We accessed the target group through their registered personal e-mail address at their professional organization website. We analyzed the results using descriptive statistics.

Results:
We invited a total of 3052 surgeons to participate. Overall, 192 from 47 countries responded and competed the survey in between February 11 and April 11, 2016. The experience of the surgeons ranged between 2 to 50 years, with a median of 20 and mean (±SD) of 20.81±9.96.
Nearly half of the participants were practicing in academic medical centers and over one third responded that their working institution owned a hyperbaric chamber. While nearly one third of the surgeons never ever referred a patient to HBOT, 74 responded to have referred between one to ten patients with non-healing wounds in the past year. A vast majority (83.68%) of the surgeons believed that, among several indications related with their specialty, HBOT was most beneficial in treating non-healing wounds. Among surgeons who have never referred a patient to HBOT, almost half cited logistic limitations as the most significant barrier to HBOT. Additionally, lack of robust scientific evidence for HBO, high cost and lack of coverage by national insurance companies were also cited as other barriers to HBOT.

Conclusion:
Our results demonstrated that logistic limitations and lack of robust scientific evidence for HBOT are the two most important barriers to HBOT use among plastic surgeons.

P-08 ALTERATIONS IN TASTE PERCEPTION AS A RESULT OF HYPERBARIC OXYGEN THERAPY IN PATIENTS WITH NON-HEALING WOUNDS

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Objectives:
The evaluation of the effect of hyperbaric oxygen therapy (HBOT) on taste sensitivity, hedonic perception of taste, and food preferences in patients with non-healing wounds.

Methods:
79 patients (H group) were treated with HBOT due to chronic non-healing wounds. C group (118 people) consisted of healthy people did not receive HBOT. The taste intensity, recognition thresholds, and hedonic perception were examined using gustatory tests. The solutions of sucrose (sweet), sodium chloride (salty), citric acid (sour), quinine hydrochloride (bitter), and monosodium glutamate (umami) were used. The participants fulfilled the questionnaire to examine pleasure derived from eating certain types of dishes. Gustatory tests and analyses of the pleasure derived from eating in the H group were carried out before the first exposure to hyperbaric oxygen and after at least 25 sessions of treatment. In the C group, examination of perception of taste sensations was conducted only once.

Results:
The recognition thresholds for sweet ($p=0.08$), umami ($p<0.001$), sour ($p<0.01$) and bitter ($p<0.001$) were decreased after therapy. The intensity of taste sensation increased after therapy for the 0.1%, 0.3%, 1.0% monosodium glutamate ($p<0.05$, $p<0.05$, $p<0.001$); 0.1% citric acid ($p<0.01$); 0.36% sodium chloride ($p=0.07$) and 0.005% quinine hydrochloride ($p=0.07$) concentrations. For the solutions of 10% sucrose, 0.1% citric acid, and 0.36 % sodium chloride hedonic responses were lower after treatment at $p<0.05$; $p<0.01$ and $p=0.08$ respectively. After HBOT sweet desserts ($p<0.01$); chocolate ($p<0.001$) and crisps ($p<0.05$) were described as less pleasant than before HBOT.

Conclusion:
Patients with non-healing wounds compared to healthy people are characterized by reduced taste sensitivity. After HBOT the improvement in perception of taste sensations and changes in hedonic evaluation have occurred among patients with non-healing wounds. In terms of food preference, a decreased desire for eating sweet desserts, chocolate, and crisps was observed in those patients who received HBOT.

Key words: Food Preference, Hyperbaric Oxygen Therapy, Non-healing Wound, Taste

P-09 HYPERBARIC OXYGEN THERAPY FOR CERVICAL NECROTIZING FASCIITIS OF ODONTOGENIC ORIGIN IN A HEALTHY YOUNG PATIENT

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Background:
Necrotizing fasciitis (NF) is a severe soft tissue infection and can progress rapidly. It's predominantly seen in extremities, perineal ara and abdominal wall. Occurence in cervical area is uncommon and is usually related to dental infections. Agressive treatment should be initiated promptly to overcome high mortality and morbidity. Adjuntive hyperbaric oxygen therapy has been shown to beneficial in the management of NF.

Methods:
A cervical necrotizing fasciitis case treated in our hyperbaric oxygen therapy unit is presented.

Case:
A 33-year old healthy female patient had a story of right side neck swelling and erythema one day after a tooth extraction. She presented to the hospital with pus drainage from the right mandibular area and was diagnosed with cervical NF. The involved area was debrided and intravenous antibiotherapy was started at the Ear Nose and Throat Department. She was reffered to our center and HBO was initiated immediately. Hyperbaric oxygen therapy was applied at 2.4 ATA for 120 minutes. The patient improved quickly with wound care, antibiotherapy and HBO. When appropriate granulation tissue grew, split thickness skin graft was applied. She was discharged on the 32nd day.

Discussion:
Cervicofacial NF is commonly seen in immunocompromised patients and related to dental pathologies. Pain may be the only symptom at early stages and tissue necrosis may occur on the 4-5th day. Mediastinitis, pleural empyema and septic shock may develop and cause severe morbidity or mortality. Aggressive debridement and intravenous antibiotherapy are the first line treatments. Patients usually need repeated debridements. Adjuvant HBO has been shown to decrease mortality, hospitalization time and need for debridements in these patients. In our case, further tissue necrosis did not develop and additional debridement was not needed after HBO was started. HBO treatment is beneficial in the management of cervicofacial NF.

Key words: Cervicofacial necrotizing fasciitis, hyperbaric oxygen

P-10 PREDICTORS OF POOR OUTCOME IN PATIENTS RECEIVING HYPERBARIC OXYGEN THERAPY FOR DIABETIC FOOT ULCERS

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Introduction:
Hyperbaric oxygen (HBO) therapy is an adjunctive therapy that enhances wound healing in diabetic foot ulcers and reduces lower limb amputation rates.

Methods:
In our study, we aimed to evaluate the factors that may affect the results of HBO therapy on wound healing and amputation rate in diabetic foot ulcers. The patients, who received HBO therapy between 01 January 2013 and 31December 2014 were retrospectively enrolled into our study. There were 158 patients with 179 diabetic wounds. Treatment outcomes of the patients were classified into 4 groups; major amputation, minor amputation or grafting, healing, and no change. Demographic and medical data of patients, Wagner and PEDIS stages were recorded and the factors that lead to amputation were investigated.

Results:
Twenty-one of the 179 wounds underwent (11.5%) major amputations, 80 wounds (43.7%) underwent minor amputation or grafting. Sixty-six wounds (36.1%) healed and there was no change in 12 wounds (6.6%). We observed that the increase in Wagner stageled to increased amputation rate and decreased healing rate ($p<0.001$). Similarly, the increase in PEDIS stage led to increased amputation rate ($p<0.001$). While none of the patients without peripheral arterial disease underwent major amputation, 15.1% of patients with peripheral arterial disease underwent major amputation. It was found that peripheral arterial disease negatively affectedthe outcome ($p=0.025$). In cases with anemia (Hb<10 g/dL), major amputation rate was 21.1%, minor amputation/grafting rate was 44.7%. In cases without anemia (Hb>10 g/dL), these rates were 8.9% and 46.7%, respectively. The difference between the patients with and without anemia was not significant ($p=0.197$).

Conclusions:
In conclusion, the major amputation rate was 11.5% in patients receiving HBO therapy for diabetic foot ulcer. The risk of amputation is increased in cases with high Wagner grades, PEDIS infection stages and peripheral arterial disease. Wagner and PEDIS stages are beneficial to predict treatment outcomes in patients with diabetic foot ulcers receiving HBO therapy.

Key words: HBO, Diabetic foot, Wagner, PEDIS

P-11 MICROVASCULAR, BIOCHEMICAL AND CLINICAL IMPACT OF HYPERBARIC OXYGEN THERAPY IN RECALCITRANT DIABETIC FOOT ULCERS

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Introduction*:*
Oxygenation of diabetic foot ulcer (DFU) by hyperbaric oxygen therapy (HBOT) promotes wound healing. However, human studies on local and systemic efficacy are scarce.

Objective:
To assess HBOT impact on serum markers modulation, local microvasculature and DFU clinical outcome.

Methods:
A non-randomized trial, performed in a tertiary care unit diabetic foot clinic. Subjects with recalcitrant DFU were treated with HBOT (n=14) or standard care (n=6). The HBOT treatment protocol was a 80 minutes session at 2.4 ATA, once a day, five days a week (maximum 100 sessions). Short term endpoints included laboratory markers and DFU dimensions collected at baseline and after 3 months. DFU healing, LEA and death occurrence were collected at 6 and 12 months. Long term endpoints were collected after 3 years of follow up and included DFU recurrence, LEA and death.

Results:
Groups were identical with a sample mean age of 62 years and 18-year DM duration, mostly men, with type 2 DM, insulin-treated, with several complications. After 3 months of HBOT, subjects presented a reduction on erythrocyte sedimentation rate ($p<0.05$), C-reactive protein, vascular endothelial growth factor, placental grow factor ($p<0.1$) and all DFU measurements ($p<0.1$). No differences were found in the control group. Microvessels in the DFU tended to increase upon 1 month HBOT. At every time-points, HBOT group achieved less amputation and death rates and DFU reduction. At 3 years, less amputation rates were maintained.

Conclusions:
Our data reinforces the potential molecular and clinical efficacy and benefit of HBOT when added to DFU standard treatment.

P-62 HYPERBARIC OXYGEN THERAPY (HBOT) IN DIABETIC FOOT ULCERS (DFUS): VALUE FOR MONEY

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Methods:

To evaluate the value of the HBOT for the money spent, the Number Needed to Treat (NNT) was used. The NNT is the estimate of the number of patients that need to be treated (in relation to the number of HBOT sessions for each patient) in order to have an impact on one person (healing, reduction of the amputations). The NNT value, extrapolated from the study of Faglia (1996)[1], is 4 up to 35 HBOT sessions. In Londhal (2010), the NNT is 3 for more than 35 HBOT sessions.[1-2]

Results:

The European Committee for Hyperbaric Medicine (ECHM) experts were contacted (for a survey) to know the cost of each HBOT session and of amputation. The latter value is not homogenous. The most robust value is for the United Kingdom (NHS) where the average cost of a leg amputation is GBP (£) 12,000. The costs for prosthetic limbs, rehabilitation and wound care in the year after an amputation is GBP 20,000. There are a number of other costs associated with the care of a person after a leg amputation. These include home adaptations, community care, care homes and wheelchairs. These costs are likely to be borne by local authority social services departments.[3] In order to have an homogenous value for money spent, the cost of amputation was standardized for the UK (NHS) value. Data of the USA were included for comparison.

Discussion:

In all the Countries examinated, the HBOT cost is from neutral to likely saving, execept of Norway and USA where the cost pressure for the NHS of HBOT is significantly high (due to the high cost of each HBOT session). The value for money spent remains exactly the same when the number of the HBO sessions increases more than 35. (Table 1-2)

Table 1.
Value for money spent: 30 HBOT session (NNT 4). The cost of amputation is standardized for the NHS UK value

Nation	Cost HBOT session (€)	Number HBOT sessions	NNT	Cost HBOT to save an amputation (€)	Standard (NHS_UK) cost amputation (€)	Value for money (€)
Belgium	110	30	4	13.200	37.521	24.321
Czech	70	30	4	8.400	37.521	29.121
France	222	30	4	26.640	37.521	10.881
Italy	81	30	4	9.720	37.521	27.801
Malta	35	30	4	4.200	37.521	33.321
Norway	367	30	4	44.000	37.521	- 6.479
Spain NHS	50	30	4	6.000	37.521	31.521
Spain private	150	30	4	18.000	37.521	19.521
Turkey NHS	19	30	4	2.280	37.521	35.241
UK	197	30	4	23.640	37.521	13.881
USA	364	30	4	43.680	37.521	- 6.159

Table 2:
Value for money spent: 40 HBO session (NNT 3). The cost of amputation was standardized for the NHS UK value

Nation	Cost HBOT session (€)	Number HBOT sessions	NNT	Cost HBOT to save an amputation (€)	Standard (NHS_UK) cost amputation (€)	Value for money (€)
Belgium	110	40	3	13.200	37.521	24.321
Czech	70	40	3	8.400	37.521	29.121
France	222	40	3	26.640	37.521	10.881
Italy	81	40	3	9.720	37.521	27.801
Malta	35	40	3	4.200	37.521	33.321
Norway	367	40	3	44.000	37.521	- 6.479
Spain NHS	50	40	3	6.000	37.521	31.521
Spain private	150	40	3	18.000	37.521	19.521
Turkey NHS	19	40	3	2.280	37.521	35.241
UK	197	40	3	23.640	37.521	13.881
USA	364	40	3	43.680	37.521	- 6.159

Note: In Belgium the cost of HBOT is estimated because the Belgium NHS reimbursement is restricted to first and second day of treatment.

References:

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P-12 STIMULATING FERMENTATION BY THE PROLONGED ACCELERATION OF GUT TRANSIT PROTECTS AGAINST DECOMPRESSION SICKNESS

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Introduction:
Massive bubble formation after diving can lead to decompression sickness (DCS) that can result in central nervous system disorders. We previously showed that gut fermentation at the time of a dive exacerbates DCS, an effect due to endogenous hydrogen production. We set out to see if long-term stimulation of fermentation as a result of polyethylene glycol (PEG)-induced bowel transit acceleration before diving exacerbates DCS in rats.

Methods:
Seven days before a dry dive in a hyperbaric chamber, 60 rats were randomly divided in two groups: an experimental group treated with PEG (n=30) and an untreated control group (n=30). Exhaled hydrogen, a reflection of gut fermentation, was measured before the dive. Signs of DCS were observed on removal from the hyperbaric chamber, i.e. motor deficit, moving difficulty or death. Blood counts were done before and after the dive. After anaesthesia, arterial blood was drawn to assay inflammatory cytokines and markers of oxidative stress.

Results:
PEG led to a significant increase in exhaled H_2 (35ppm [10-73] compared with 7ppm [2-15]; p=0.0011). Surprisingly, deaths were fewer among the PEG-treated rats (17% [95%CI 4-41] versus 50% [95%CI 26-74]; p=0.0339). In parallel, drop in platelet count was significantly smaller in the PEG Group (-6.0% [-9.6;-0.8] versus -15.4% [-19.6;-8.5]; p=0.0256), and levels of inflammatory markers were lower. Antioxidant activity of glutathione peroxidase was significantly higher in the PEG Group (525.417±92.867U.l^{-1} versus 378.495±74.385U.l^{-1}; p=0.0010).

Discussion and conclusion:
Long-term stimulation of fermentation between dives seems to reduce DCS risk in rats. Our findings point to a two-edged effect of gut fermentation on decompression: although deleterious at the time of diving, longer-term gut fermentation between dives might have a positive effect. H_2 with antioxidant properties and butyrate with neuroprotective activity are both fermentation by-products which could explain these results.

Key words: Decompression Sickness, Fermentation, Gut Transit, Hydrogen, Butyrate

P-13 DESIGN OF AN UNDERWATER GLUCOSE MONITORING SYSTEM FOR DIABETIC SCUBA DIVERS

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Introduction:
Despite the abundance of telemetric applications for ecology, behavior and physiology of marine life, few efforts were reported about the use of acoustic telemetry for SCUBA divers. This study is about a system for monitoring the glycaemia of scuba divers while underwater.

Methods:
Electromagnetic waves are absorbed by water and the acoustic telemetry is the only effective method for wireless underwater monitoring. The system consists of a G4 Platinum subcutaneous sensor to measure interstitial glycaemia (Dexcom Inc, San Diego, CA), an open-source RF receiver board (Wixel) based on the CC2511F32 microcontroller (Texas Instruments Incorporated, Dallas, TX) in a waterproof casing, a pair of acoustic modems SMA-1 (Desert Star Systems LLC, Monterey Bay, CA) to transmit data underwater and a computer on the surface to log the received data. The design of this system was completed and a prototype has been built. The reliability of the acoustical data link was tested in a swimming pool where an acoustical data link is established between two computers located at surface.

Results:
The acoustical link experiments were successful for 20 minutes of simulated signals for the depth, interstitial glycaemia, breathing frequency and temperature information. The overall efficiency was 80.1%, with 474 bytes sent and 378 bytes received. The whole system is tested to 11 Bar and is ready for the open water tests.

Discussion:
The bandwidth of the acoustical link is very low (max 4 reading/min) but is adequate for glycaemia monitoring. The system is beneficial for studying diabetic scuba divers, allowing their supervisors to monitor their interstitial glycaemia and trend during the dive and share the recorded values in a database.

P-14 THE OUTCOME OF SATURATION DIVING ON ENDOTHELIAL FUNCTION AND BIOMARKERS OF VASCULAR HEALTH IN PROFESSIONAL OFFSHORE DIVERS

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Introduction:
It has been shown by previous studies that saturation diving affects the vascular system and triggers inflammatory-like reactions. Some of the saturation diving impacts on the endothelial function can be measured by a series of tests including measurement of the Flow Mediated Dilation (FMD) of the brachial artery and measurement of specific biomarkers that can be found in the blood, before and after a period of saturation.
It was also reported that antioxidants have the ability to reduce the stress biomarkers and protect the vascular system. The antioxidant effect of vitamins C and E was measured by monitoring the levels of these biomarkers in the divers who have been given vitamins tablets and the control group.

Methods:
A total of 20 saturation divers on the DSV Skandi Arctic, all males in good physical health were tested. They were all submitted to FMD tests and blood samplings; pre- and post-saturation. The FMD readings were analyzed. ELISA assays and biochemical tests were conducted to quantify the blood stress biomarkers.

Results:
There was no statistically significant difference in FMD between the two diving groups with (p=0.753) and without (P=0.515) vitamin supplementation. No effects were found in plasma biomarkers with or without vitamins: IL-6 (p=0.968), PAI-1 (p=0.536), ICAM-1 (p=0.588), CRP (p=0.279), fibrinogen (p=0.464).

Conclusions:
The FMD and blood biomarkers levels showed no significant difference pre- and post-saturation. The vitamins C and E dosages chosen showed to have no significant impact on the biomarkers levels.

P-15 JOULE & THOMSON MIGHT BE RESPONSIBLE FOR FATAL DIVING ACCIDENTS

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Background:
Fatal diving accidents in Germany/Switzerland/Austria mainly occur during dives in cold Alpine waters (10 to 2°C). We present 7 cases collected in Germany in the past 10 years. In all these cases freezing of the regulator triggered the fatal outcome.

Methods:
To support court decisions, an officially appointed and sworn expert for underwater equipment (D.B.) conducted the investigations. Among the normal equipment (diving suit, cylinder, regulator, stabilizing jacket, weights), dive computers and breathing gas data were in the centre of examination.

Results:
The experience of the 7 male divers (23–52yrs) varied from zero to highly decorated diving instructors. The dives (cylinders from 1x7 to 2x12L) were started with filling pressures between 190–275 bar. Thus, the fatalities happened within a wide range of human factors and technical equipment. On the other hand, the fatal accidents had in common that they were triggered after freezing of the regulator at tank pressures of about 180–160 bar. This pressure range was observed regardless of which the initial breathing gas reservoir was. There seems to be evidence, that not the diving time but the gas pressure had triggered the beginning of regulator freezing.

Discussion:
According to the Joule–Thomson effect, (breathing) gas temperatures will decrease downstream a nozzle. Temperature maximally decreases around 180–160 bar reaching values up to 25°C. This decrease also depends on the gas temperature within cylinder. After reaching the critical pressure range, regulators might freeze. After freezing of the first stage, freely flowing breathing gas causes both severe stress and rapid reduction of the gas reserve. If no adequate emergency program is available, such a situation might induce a panic reaction, and drowning might become the cause of death.

P-16 THE EUROPEAN DIVING MEDICINE DATABANK (EDMD)

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Centro Iperbarico Ravenna, Ravenna, Italy, HBOT, Ravenna, Italy [3]

Background:
The working conditions of Certified Commercial Divers (CCD) are extremely heavy. They stay for a long time (typically 4 consecutive week) in extreme hyperbaric environments: underwater or hyperbaric chambers, breathing high pressure Oxygen and Helium gas mixtures resulting in tissue saturation of the used inert. They need assistance for their health and work fitness by divers' medical examiners (MEDs).

Methods:
We have developed a web-site (European Diving Medical Databank (EDMD): www.edmd.eu) with a databank in order to access all the information related both to the medical records of CCDs and the availability of MEDs in the European countries.
According to the revised educational standards of the European Diving Technology Committee (EDTC), an International Diving Medical Expert Board (IDMEB) was created for assuring quality standards of the EDMD. The EDMD is hosted at the Scuola Superiore Sant'Anna University in Pisa, and operates with support by the EDTC, the Diving Medical Advisory Committee, the European Committee for Hyperbaric Medicine and the South Africa Underwater and Hyperbaric Medical Association, which provided the main features to implement the Databank.

The EDMD website, technically managed by Institute of Clinical Physiology of National Research Council (CNR, Pisa, Italy) allows to access a specialized databank for finding and locating certified MEDs in the several European Countries, and for collecting in medical records the CCD's health and work fitness information in a standardized way.

Discussion:
At today, the EDMD website is fully operative and the system operability resulted very satisfactory. Firstly, it was public opened for MEDs, giving information about selected MEDs, their practice addresses and specific qualifications. MEDs are allowed to insert diving medical certificates of examined CCDs in order to be consulted by employers or other MEDs. Now, we are extending the portal access to CCDs. Our future prospective is creating a homogeneous worldwide net of diving medicine, allowing also non-Europeans to join the databank.

P-17 EPIDEMIOLOGY OF MORBIDITY AND MORTALITY IN US AND CANADIAN RECREATIONAL SCUBA DIVING

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Introduction:
Scuba diving is a popular recreational pursuit enjoyed by millions of divers worldwide. This study investigates morbidity and mortality suffered by divers in the US and Canada.

Methods:
The National Electronic Surveillance System (NEISS) and Canadian Hospitals Injury Reporting and Prevention Program (CHIRPP) were searched for scuba diving injuries. The Divers Alert Network (DAN) diving fatality database was searched for deaths and Sports and Fitness Industry Association (SFIA) estimates for diving were obtained from annual surveys.

Results:
In the US there were an estimated 1,394 emergency room (ER) presentations annually for scuba-related injuries. The majority (80%) were treated and released, or released without treatment. Less than 1% were dead on arrival or died in the ER. There were an estimated 306,174,386 dives made by US residents 2006-2015 and concurrently there were 563 recreational diving deaths, a fatality rate among US recreational divers of 0.18 per 10^5 dives and 1.8 per 10^5 diver-years. There were 658 diving deaths in the US 2006-2015 and 13,943 ER presentations for scuba injuries, a rate of 47.2 deaths per 1,000 ER presentations. There were 98 cases of scuba-related injuries identified in the CHIRPP data. The prevalence of scuba-related injuries for patients aged 0-17 years was 1.5 per 10^5 cases, and the prevalence of scuba related-injuries to patients 18-62 years per was 16.5 per 10^5 cases.

Conclusion:
In Canada and the US only one out of every 10,000 ER presentations is due to a scuba–related injury. That there are 47 deaths for every 1,000 ER presentations speaks to the relatively unforgiving environment in which scuba diving takes place. At 1.8 deaths per million recreational dives, mortality in scuba diving is nonetheless relatively low. As with calls to the DAN Emergency Helpline, barotrauma and DCS were the most common injuries seen at the ER.

Key words: Barotrauma, CHIRPP, Decompression, Emergency Room, Fatality Rate, NEISS.

P-18 SKISCUBASPACE PROJECT: HUMAN PERFORMANCE ALONG THE PRESSURE CONTINUUM

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Introduction:
In the frame of the DAN/Altec "SkiScubaSpace" Project, aiming at investigating similarities and differences of human exposure to extreme conditions, we developed a “wearable technology” approach allowing for real-time bi-directional transmission, recording and analysis of physiological parameters from subjects exposed to remote, hostile environments.
The first test of the system was made during a solitary oceanic sailing, implying a long-term exposure to severe and remote environmental conditions allowing the wearable technology” and the data-transmission network.
The scope of this presentation is not to show the result of the study but to inform the Diving Research Community about the progress of this project during its first year and to promote collaboration with new interested institutions.

SkiScubaSpace & Sailing:
One Subject (MZ) involved in the 2017 edition of the “OSTAR” Solitary Oceanic Sailing, was continuously monitored for the entire duration of the Ocean crossing for heart activity, respiratory frequency and glycaemia, every 5 minutes from two days before to two days after the competition, using an originally developed wearable sensor technology.
Data were constantly sent to the DAN Mission Control Centre for real time continuous medical supervision and necessary support and MZ was constantly informed about his health state by the system’s bi-directional data transmission utility.
This “beta” test of this wearable technology approach has proven pivotal to assess and improve the reliability of the monitoring instruments in severely adverse conditions.

SkiScubaSpace:
The next step of the project will be using the “wearable technology” and the connected data-transmission network we tested during oceanic sailing during High altitude, Scuba and Space activities, aiming at advanced, real-time, exceptional human exposure medical investigation
The scientific findings resulting from this project are expected to provide valuable information on the nature and “management” of differences in human response to exposure to variable oxygen and pressure.

P-19 NO CHANGES IN PULMONARY FUNCTION INDICES AFTER NITROX SATURATION DIVES

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Introduction:
Nitrox saturation dives have been carried out with the UEG/CIRIA nitrox saturation table to verify the suitability of this table to handle a rescued crew from a disabled submarine with increased internal pressure.

Methods:
Two dives with 36-hour saturation periods at 15 msw and 30 msw respectively were carried out with 4 divers in each. The shallow dive was made with air (PO_2 at depth: 53 kPa), and the deep dive with nitrox (constant PO_2 at 50 kPa) until a shift to air at 15 msw during decompression. Decompression rates were 1 msw per 2h from 30 msw to 15 msw, and from 15 msw to surface 1 msw per 2 h 40 min. Static and dynamic spirometry and carbon monoxide diffusion capacity were measured (Quark PFT, Cosmed, Italy) prior to compression and 1 hour and 18 – 25 hours post-decompression.

Results:
None of the divers complained of any respiratory symptoms either during or after the dives. None of the variables (VC, FVC, FEV_1, FEV%, PEF, FEF(25-75), MEF50%, DLCO, or calculated membrane diffusion capacity (D_M)) showed any significant changes post dive. However, one diver with concave baseline flow-volume curve showed an initial reduction of FEV_1 by 16.5% and by 23.1% after 18 h. After 18 h D_M was reduced by 15.5%.

Conclusion:
The levels of PO_2 used in these dives did not cause any signs or symptoms of pulmonary toxicity on a group level. Thus, the PO_2 used in these dives does not appear to be excessive. However, one subject with tendency to obstructive changes during base-line spirometry showed a further worsening of spirometric indices post-dive. Thus, for sensitive subjects, or for submariners exposed to periods with higher oxygen partial pressures or contaminated atmospheres, even this level of PO_2 may cause some pulmonary function deficits.

Key words: Pulmonary Oxygen Toxicity, Dynamic Spirometry, Diffusion Capacity, Saturation Dive

P-20 RECOMPRESSION TREATED DECOMPRESSION ILLNESS SIGNS AND SYMPTOMS – INITIAL FINDINGS AND 2-3 MONTHS FOLLOW-UP

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Introduction:
Decompression illness (DCI) is a feared complication of scuba diving which may cause a range of symptoms from different organ systems. For persisting or more severe symptoms, hyperbaric oxygen is recommended as therapy of choice, leading to a considerable symptom-reduction in the majority of cases. However, available data are focused on a relatively small range of symptoms and are sparsely with respect to long-term outcome beyond the time of discharge.

Aim:
We aimed to study a broad range of DCI-related symptoms and their development over time, and to identify factors associated with residual symptoms.

Materials and methods:
Divers admitted to our hyperbaric unit, diagnosed with decompression illness or arterial gas embolism and treated with hyperbaric oxygen, were prospectively included. Investigations included questionnaires on demographic data, risk factors, quality of life (VAS scale 0-100) and a total of 20 subjective symptoms (Lickert scale 0-5) at admission, discharge and after 2-3-month follow-up.

Results:
Thirty-seven divers were included, 31 answered the questionnaires at discharge and 28 at follow-up. At discharge and follow-up 45 % and 46 % respectively, were free from symptoms. Tiredness was the most frequent symptom at discharge and follow-up (39 % and 32 %, respectively), while tingling (14 %), concentration-difficulties (14 %) and ear-ringing (11 %) were frequent persisting symptoms. Symptoms were overall little changed after discharge. There was an association of residual symptoms at follow-up with more severe initial symptoms, but not with dive-related risk factors or reduced quality of life.

Conclusions:
In our population, about 50% had at least one residual symptom 2-3 months after DCI, although usually mild. Persisting symptoms seem to be associated with more severe initial symptoms, but not with factors known to increase the risk for DCI as such.

Key words: Decompression Illness, Hyperbaric Oxygen, Tiredness, Tingling, Paraesthesia

P-21 CASE REPORT: DECOMPRESSION ILLNESS IN HYPERBARIC CHAMBER INSIDE ATTENDANT

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Introduction:
Decompression illness (DCI) is caused by bubbles in blood or tissue during or after a reduction in environmental pressure and is primarily a disease of exposure to high partial pressures of nitrogen. As well as other occupations exposed to work in high pressure conditions, hyperbaric chamber inside attendants are also at risk of DCI.

Case report:
We report case of decompression illness (Type I) in a 35-year-old hyperbaric chamber attendant. Attendant presented with itching of the inside of both upper arms and redness on inside of left lower leg and neck 45 minutes after surfacing from a treatment of patient with gas gangrene. Attendant exposure during patient treatment was: descend in 40 min to 3 ATA (due to patient problems with performing Valsava maneuver), remain for 150 min, ascent to 1.8 ATA, breathe 100% O2 during whole ascent, of which 12 min during ascent from 18m to 6m and during decompression stops on 6m for 5min and on 3m for 32 minute.
Beside prolonged descend, there was no other problems or deviation from the standard decompression protocol therapy. Attendant had the last dive 4 days prior to incident dive. Clinically, neurological status was normal also as the examination of the respiratory system, cardiovascular system and the abdomen. Attendant was managed with the standard recompression treatment according TT6 USN with one extension and 3 standard HBO therapy on 2.4 bar with complete resolution of symptoms on conclusion of the therapy. Chest radiography, electrocardiography (ECG) and spirometry were found to be normal but on echocardiography patent foramen ovale (PFO) was found.

Conclusion:
DCI in inside medical attendant is rare but risk is higher if predisposing factors for DCI are present.

Key words: Decompression Illness, Hyperbaric Chamber Medical Attendant, Patent Foramen Ovale

P-22 IMMERSION PULMONARY EDEMA WITH REBREATHER AMONG FRENCH MILITARY DIVERS FROM 2009 TO 2015: ROLE OF HYDROSTATIC IMBALANCE

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Introduction:
The use of rebreathers for underwater military operational activities potentially expose the diver to immersion pulmonary edema (IPE) since the hydrostatic pressure gradient between the lung centroid and the breathing bag of diving equipment when this is positioned at a shallower depth than the diver's thorax increase the negative inspiratory load enough to contribute to substantial fluid shift from pulmonary capillaries to alveoli. At present, IPE was anecdotally reported with type of device. We therefore analyze the epidemiology of this injury in military divers using a rebreather with the aim to highlight the influence of hydrostatic imbalance as potential risk factor.

Methods:
IPE cases recorded in the French military database between 2009 and 2015 were retrospectively investigated with a specific emphasis on anthropometric data, details of incident dive, laboratory evaluations, breathing equipment expertise and outcomes.

Results:
21 episodes of IPE were reported in 20 male military divers (31±7 years, 24.4 ± 2.6 kg/m^2), corresponding to 21.3% of all diving disorders with rebreathers collected during the study period (incidence rate of 1 case per 9500 exposures). The water temperature was 14 ± 4 °C. All cases involved mounted back breathing equipment, and one third of these dives consisted of training dives with strenuous exertion. All patients had complete resolution within 12 hours and follow-up investigations (echocardiography, spirometry, exercise testing) ruled out any cardio-pulmonary disease. In 33%, there was a lack of adjustment of the device's valves by the users.

Conclusion:
Negative-pressure ventilation when the breathing bag of the rebreather is located above the pulmonary centroid appears to be a triggering condition for IPE development in military divers. Ongoing studies in collaboration with the manufacturer and the military authorities are warranted to reduce the extent of hydrostatic imbalance imposed by a rebreather worn on the back. Caution should be also made on rebreather maintenance.

Key words: Immersion Pulmonary edema, Diving, Rebreather, Hydrostatic imbalance.

P-23 ASCENT EMERGENCY TRAINING AND PULMONARY BAROTRAUMA IN TRAINEE MILITARY DIVERS.

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Background:
A review of diving injuries recorded from 1991 to 2016 in the French Army identified 33/549 (6%) cases of pulmonary barotrauma (PBT) following scuba diving, including 18% with cerebral arterial gas embolism (CAGE) and one fatal case. Since 76% of PBT cases occurred during the initial training, our objective was to study the risk of this event in trainee divers at the French Navy diving school over a 12 years period (2004-2016).

Methods:
We found 15 cases of PBT during the study period. 73% (11/15) occurred during Emergency Ascent Training (EAT) drills from 15 msw to the surface. In all of these cases, a controlled ascent rate by means of finning with continuous exhalation during the vertical ascent was respected.

Results:
The incidence of PBT is estimated to 9.3 cases/10000 training dives with EAT vs. 0.84/10000 training dives without EAT [$p<0.0001$, OR=11.1, 95% CI (3.5-34.8)]. 27% (4/15) of PBT were identified as severe including 3 cases of CAGE and one fatal case, all occurring during EAT, and underwent prompt recompression using a 4 ATA Nitrox table.

Discussion/Conclusion:
Based on these data, maintaining the practice of EAT seems questionable. However, the benefit of this technique was suggested in a recent French navy report describing 18 cases of real emergency free ascent without clinical consequence since 2004. According to the US Navy and other diving authorities, it was agreed to adopt safer measures to EAT, i.e. a reduced pressure ratio < 1.5 during vertical ascent with a specific range of depths (4msw-surface; 15msw-7msw and 17msw-9msw) and the addition of an exhalation period during 4 sec before ascending to the surface.

P-24 BREATH HOLD DIVING-INDUCED ACUTE PULMONARY EDEMA. NEW PATHOPHYSIOLOGICAL INSIGHT FROM UNDERWATER DOPPLER-ECHOCARDIOGRAPHY

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Introduction:
The pathogenesis of Swimming-Induced Pulmonary Edema (SIPE) has not yet been fully clarified, mainly due to the scarcity of data coming from a direct evaluation of free diving or swimming subjects. Recent evidences suggest possible pathophysiological parallelisms between SIPE and High-Altitude Pulmonary Edema (HAPE), mainly due to hypoxic pulmonary vasoconstriction. Breath-hold diving, combining hypoxia and immersion, is likely to be the most powerful trigger for SIPE (reported in 25% of high level breath-hold divers) and the best model to investigate its pathogenesis.

Methods:
We used a submersible echocardiograph, suitable for the study of free-diving subjects up to a depth of 30m.

Results:
We observed, during breath-hold diving, the appearance of a constrictive left ventricular diastolic filling pattern.

Conclusions:
On the basis of these data, breath-hold diving–associated SIPE may be the result of several stimuli: hypoxia, pulmonary capillary congestion due to immersion and left ventricular diastolic impairment. A possible common pathogenetic pathway for all the forms of environment-induced pulmonary edema can be delineated.

P-26 12 CASES OF VESTIBULAR DECOMPRESSION SICKNESS WITH CLINICAL MONITORING AND RECORDING OF VIDEO. HOSPITAL ANCUD. CHILE

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Hospital Ancud, Hospital Ancud, Ancud, Chile [1]

Introduction:
The objective is to show the characteristics and evolution of the cases of Vestibular Decompression Sickness (D.S.) treated in our Center.

Materials and method:
We made a prospective and descriptive study from February to September 2014 of 12 cases with symptoms of vestibular DS. Diagnosis was clinical and there are videos of follow-¬up.

Results:
Most of the patients presented a unilateral clinical picture, virtually all cases occurred in over 35 years. And the average age was 45, 5 years; One patient required ICU by serious DS associated. The time of onset of symptoms to treatment in CHB was on average 11 hours, the omission of decompression time was on average 100 minutes. Four patients presented vestibular bilateral DS and stayed with sequels, six showed left vestibular DS, and 2 right vestibular DS, all with normal neurovestibulars clinical test at discharge, which leads us to conclude that unilateral DS vestibular has better prognosis.

Conclusions:
There is no relationship between the time of onset of symptoms or delay in entering in the aftermath hyperbaric treatment and sequelae. .
There is no relationship between recompression in the sea and residual symptoms of the disease, notably 2 divers who made recompression at sea required more than 6 retreatment sessions. In addition, we found that there is no relationship between the startup time of CHB treatment and prognosis.

AGE	MAXIMUM DEPTH (meters)	START OF SYMPTOMS	TIME TO BEGINNING HBO (HRS)	SUSPECTED POISONING ASSOCIATED.	DIAGNOSIS	No. SESSIONS RETREATMENT	MEDICAL CONDITION AT DISCHARGE
54	30	30 MINUTES	5	YES	BILATERAL	6	Symptomatic
47	18	1 HOUR	12	YES	BILATERAL	8	discontinuated treatment
60	17	IMMEDIATELY	11	NO	UNILATERAL	5	Normal
18	30	IMMEDIATELY	13	NO	UNILATERAL	13	Normal
37	20	20 MIN	12	NO	BILATERAL	25	Symptomatic
42	18	IMMEDIATELY	8, 5	NO	UNILATERAL	12	Normal
44	20	3 HOURS	31	NO	UNILATERAL	3	Normal
47	31	IMMEDIATELY	7	NO	BILATERAL	5	Symptomatic
51	28	IMMEDIATELY	8 ,5	NO	UNILATERAL	5	Normal
53	23	IMMEDIATELY	6	NO	UNILATERAL	3	Normal
40	25	IMMEDIATELY	11	NO	UNILATERAL	11	Normal
53	18	IMMEDIATELY	72 H	NO	UNILATERAL	1	Normal

P-27 RISK FACTORS FOR SCUBA DIVING PULMONARY EDEMA IN RECREATIONAL DIVERS

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SSS Recompression Chamber Network, International Hospital, Cozumel, Mexico [1]

Objective:
To identify the risk factors associated with the development of acute pulmonary edema (PAD) in individuals who practiced recreational scuba diving, attended at the SSS Recompression Chamber Network / MHI Clinic on the Island of Cozumel, Quintana Roo, Mexico, during The period January 2013 to December 2014.

Design:
Case-control study.

Material and methods:
We identified 40 cases of EPA, each matched with two patients whose clinical picture and final diagnosis were not EPA. The data were taken from the clinical records and analyzed in a univariate and multivariate manner, applying odds ratios (MRI) and 95% confidence intervals as a measure of random error.

Result:
Eight variables were selected by univariate analysis as statistically significant and included in the multivariate analysis that identified as clinical and statistically significant age (RM 1.10, 95% CI 1.006 to 1.22, X 2 with P = 0.03), had previous physical activity (RM0.10, 95% CI 0.01 to 0.75, X2 with P = 0.02), the number of day dives (RM 0.87, 95% CI 0.006 to 0.68, X 2 with p = 0.02), immersion time (0.83 CI 95% 0.77 to 0.98, X 2 with p = 0.02) and depth of immersion (RM 0.93, 95% CI 0.88 to 0.98, X 2 with p = 0.02).

Conclusions:
Age was identified as a variable that increased risk, while four other variables - previous physical activity, number of daytime immersion, immersion time and depth of immersion - were considered as reducing or protective against EPA development.

Key words: Scuba, Recreational Diving, Risk Factors, Acute Pulmonary Edema, Decompression Sickness.

P-28 TAKOTSUBO SYNDROME ASSOCIATED WITH SCUBA DIVING PULMONARY EDEMA (SDPE)

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Objective:
Report of a case of stress cardiomyopathy and Scuba Diving Pulmonary Edema (SDPE)

Design:
75-year-old female, dive in Cozumel, Mexico. Diver certified, with 100 pre-dives, performed in two dives per day in the two days prior to the day of the accident. On the day of the accident she immerses to 84 fsw for 23 minutes, makes rapid ascent to the surface. 20 minutes after the end of the diving begins with pain in the anterior chest and lung bases and dyspnea, an hour later the dyspnea increases gradually so it goes to the Emergency Department

Material and methods:
After clinical evaluation and pulmonary ultrasound the patient is diagnosed with Scuba Diving Pulmonary Edema (SDPE), treatment is started and EKG, thorax x-ray, laboratory studies and transthoracic echocardiogram are complemented.

Result:
The patient presented electrocardiographic changes suggestive of acute coronary syndrome. The chest X-ray showed areas of bilateral interstitial and alveolar infiltrates with a radiolucent image on the left cardiac border suggestive of Pneumomediastinum. The echocardiogram identifies a dilated left ventricle, with apex in the form of a ballooning and hypokinetic, with a decrease in LVEF. Elevation of cardiac enzymes is determined. With the above mentioned symptoms the patient underwent coronary angiography. The coronary study is normal. The ventirculography showed diagnostic data of stress cardiomyopathy.

Conclusions:
This case presents a patient with Stress Cardiomyopathy, Broken Heart Syndrome or Takotsubo Syndrome. A syndrome that simulates Acute Coronary Syndrome, in this case complicated with Scuba Diving Pulmonary Edema (SDPE).

Key words: Takotsubo, Recreational Diving, Scuba Diving Pulmonary Edema (SDPE), Acute Coronary Syndrome.

P-29 MUSCULOSKELETAL COMPLAINTS AMONG PROFESSIONAL DIVERS

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Introduction:
A previous study found decreased health related quality of life among professional divers due to bodily pain as well as to other factors. This study aims to investigate which factors influence professional divers risk for musculoskeletal complaints.

Methods:
The Norwegian Labor Inspection Authority's Diving Register comprises data on all professional inshore divers who have ever held a diving certificate since 1980. Of these divers, the "Norwegian diver 2011" questionnaire was completed by 2848 (48.7%). Based on data gathered from the postal questionnaire, the prevalence of musculoskeletal complaints, strain injuries and joint pain among divers with different certification levels, decompression sickness (DCS) experiences and work related tasks, were analysed.

Results:
The risk for musculoskeletal complaints, strain injuries and joint pain was significantly higher among divers working in the quay/construction industry versus divers not working in this industry. Likewise, a higher risk was found among divers doing physically demanding work like working with vibrating and/or rotating tools, welding, construction, pipelaying and blasting. Having experienced tingling and/or numbness in fingers after working with vibrating and/or rotating tools or having sick leave due to tendonitis, periosteum inflammation, stretch injuries or sprains caused by diving were also associated with musculoskeletal pain conditions. Having experienced DCS further increased the risk for musculoskeletal complaints, strain injuries and joint pain.

Discussion/Conclusion:
Professional divers working in the quay/construction industry and divers doing tasks with heavy physical demands carry a higher risk for musculoskeletal complaints than other professional divers. This indicates that these complaints are mainly caused by the heavy physical demands rather than the increased environmental pressure per se. Furthermore, the increased risk of pain because of DCS may be caused by dysbaric osteonecrosis in or close to joints.

Key words: Professional divers, Musculoskeletal complaints, Exposure, Questionnaire study

P-30 REVIEW OF HAEMATOLOGICAL PROFILE IN 47 CASES OF DECOMPRESSION ILLNESS.

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Introduction:
Hematologic variations are indicators of the gravity in the decompression disease. Recently it has been publications where it is stated that the thrombocytopenia is a common alteration in the patients. We wanted to verify this claim making a study in the patients of the unit.

Objective:
Characterize the hematologic alterations in series of patients between January of 2015 and December of 2016.

Methods:
Between 2015 and 2016, a total of 132 patients was treated for decompression illness. In this revision it is included only the ones who counted with validated backgrounds of parenteral hydration and a hematologic profile at admission, been this a total of 47 cases, agreed with that, a group of patients received parenteral hydration before to the exam taking, and the other group doesn`t.

Results:
- The average value of hematocrit was 45.45%, leucocytes of 14183/mm3 and platelets of 232640/mm3
- 3 cases presented rise in the hematocrit (6.4%), 31 leukocytosis (66%) and 3 cases of trombcytopenia (6,4%)
- in the group who received parenteral hydration previous to take exams, de average value of hematocrits was of 45.42% of leukocytes was about 15757/mm3 and of platelets was of 237840/mm3
- in the group who didn`t receive parenteral hydration previous to take exams, the average value of hematocrite was of 45.18%, of leukocytes was 10553/mm3 and of platelets was of 215270/mm3.
- there is no major variation in the results of the hematologic profile in patients who ask the same day, compared with the ones who ask 24 hours later

Conclusion:
The thrombocytopenia in the decompression illness is an isolated feature. The previous parenteral hydration seems to not affect to the hematocrits. But apparently it affects to the average of leukocytes and in lower level to the platelets.

Key words: Hematocrit, Platelets, Leukocytes, Hydration.

P-63 HEALTH, SAFETY, ENVIRONMENT AND QUALITY (HSEQ) OF THE PARBUCKLING PROJECT "COSTA CONCORDIA", GIGLIO ISLAND 2013-2015

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Introduction:
The salvage operations (the Parbuckling Project) of the wrecked Italian luxury cruise ship "Costa Concordia" which collided in January 2012 with a rock in the water of Giglio island, 18 kilometres off Italy's western coast, began in September 2013 and lasted two-year. During the process, engineers pulled the half sunken cruise ship in floating position. The initiative was designed to prepare the vessel to be towed to a specially constructed docking point near Genova for dismantling. 410 working divers were involved in the Project with a total number of 21.975 dives: 14.238 surface decompression (SurD) and 7.737 in water Oxygen Enriched Air (OEA50) decompression. The number of diving illness and accidents per month, during the project, has been gradually reduced due to the high level of attention to safety and health surveillance (Table 1).

Results:
Decompression illness (DCI) rate was reduced by empirical changes (unofficial) compared to the table USN rev 6 for SurD. For all dives with bottom time (BT) greater than 50 minutes and, for the dives with BT less than 50 min but where the diver made a considerable physical effort, all the SurD steps were increased of 5 minutes and the surface time (the time from the last step to surface) was 10 minutes. For the exceptional exposures (with an higher probability of DCI) it was used the profile immediately following the one that would really necessary.

Table 1.
The total number of diving illness and accidents during the Parbuckling project "Costa Concordia" 2013-2015

ILLNESS / DECOMPRESSION ILLNESS	**Number**
Illness during diving activity or deco (diver fainted, chest pain, hyperoxia)	7
Hyperbaric treatment for suspected diving related illness	4
Hyperbaric treatment for missed deco according dive profile	1
Injury during underwater work	1
Fatality (unrelated to diving: a rescue boat collided on the diver while working diving).	1
Near miss (no hyperbaric treatment requested)	3
total	17

P-31 A 15 YEARS LONGITUDICAL STUDY OF HEARING THRESHOLDS IN NAVY DIVERS

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Introduction:
Even though literature is inconclusive, it is widespread belief that hearing loss in divers is a result of frequent submersion and associated pressure changes. In the general working population hearing loss is common (ISO-7029). This study aims to compare the hearing loss of long term Navy divers compared to the general working population over 15 years' time.

Methods:
From 1993 up to December 2014 the Royal Netherlands Navy Diving Medical Center performed 21,298 medical screenings according to the EDTC-standards on 7,533 occupational divers. All Navy divers up to 40 years old with a diving career for at least 15 years were selected. We excluded all divers with inner ear barotrauma, inner ear DCI, missing audiometric data or dismissal from military service. Audiometric data was acquired at baseline and follow-up. A paired t-test was used for statistical analysis.

Results:
We identified 1,250 Navy divers; with 113 over 15 years' time in service. After exclusion (mainly missing audiometric data or dismissal of service) 32 divers were included. The hearing threshold increased significantly over the 15-year period at 0.5, 1 and 2 kHz (right-side) and 0.25 and 0.5 kHz (left-side). A significant hearing loss of 10 dB was found at 6 kHz on both sides. When compared to the ISO-7029 reference group, no significant difference was found.

Discussion / Conclusion:
Navy divers have significant hearing loss over 15 years’ time at 6 kHz, but this is similar to the general working population. The change at the lower frequencies can be contributed to the learning effect when performing regular audiometry. To our knowledge this is the first published study in military divers over this time interval. We conclude that military diving is no additional hazard for developing hearing loss.

P-32 IATROGENIC AIR EMBOLISM: WHEN EARLY HYPERBARIC TREATMENT IS NECESSARY?

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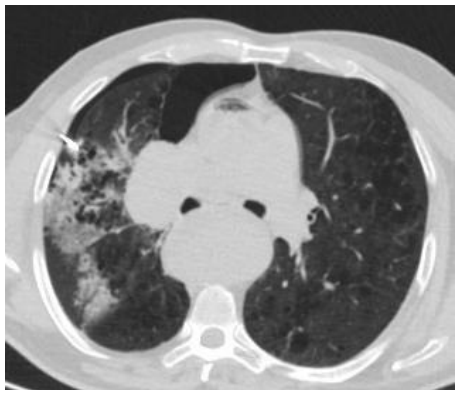
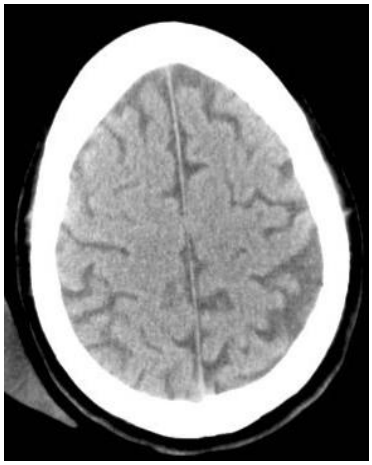
Introduction:
Iatrogenic intravascular air embolism is a rare complication that occurs during interventional radiology procedures, trauma, endoscopy, barotrauma, central line placement and removal, and surgical interventions. Symptoms and signs are non-specific: dyspnea, coughing and chest pain or sudden cardiac arrest. Neurological symptoms include: seizures, loss of consciousness, altered mental status, and hemiparesis/hemiplegia. In patients under anesthesia, reduced end-tidal CO2 may be noted. In a minority of cases, patients can be asymptomatic.
In case of PFO serious cerebrovascular complications are possible.

Patients and Methods:
From Jan, 15 to Dec. 16, 3 patients were referred to early hyperbaric oxygen treatment due to iatrogenic air embolism.

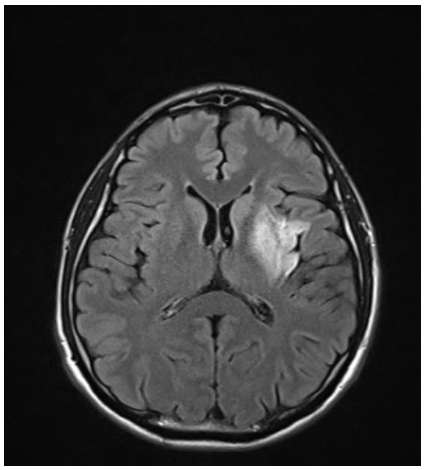
Results:
Case 1. A 61-year old man underwent CT-guided biopsy of a pulmonary lesion. Immediately after needle placement, pneumothorax, pulmonary hemorrhage and air embolism in ascending aorta presented. Then circulatory collapse, arrhythmia and loss of consciousness. The brain CT-scan confirmed cerebral air embolism. Two hours later he was treated according US Navy Table6. Only small neurological sequelae persisted.



Case 2. A 64-year old man seen in a emergency department with oppressive thoracic pain. Thoracic scan evidence of multiple air bubbles in the jugular veins and in the retrozygomatic space in a pulmonary bullous distrophy. After a US Navy Table 6 complete remission was achieved.

Case 3. A 50-year old man submitted to percutaneous closure of a PFO. At the end a difficulty in arousal was noted. At CT scan multiple air bubbles in the fronto-parietal cortical region and in the semioval centre were present. He was treated according the US Navy Table 6 and the US Navy Table 5 in the two sequent days, with complete recovery.



Discussion:
Indications of HBOT: Always in case of cerebral air embolism, as soon as possible.
Principal types of Hyperbaric Treatment: Severe cases are treated according US Navy Table 6 or COMEX CX30. Less severe cases or treated after more than 24 hours with Table 5 or 6. Consolidation treatment: 10 sessions or until clinical stability.

P-33 THE TIMING AND COURSES OF HYPERBARIC OXYGEN THERAPY FOR COMMINUTED TIBIAL FRACTURE

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Introduction:
Hyperbaric oxygen (HBO), as an effective therapy, has been early applied to treat comminuted tibial fracture. However, there is hardly agreement on the specific treatment protocols. The purpose of this study was retrospectively to observe the therapeutic effect of the timing and courses of hyperbaric oxygen therapy for this kind of injury.

Methods:
49 cases of comminuted tibial fracture were divided into hyperbaric oxygen group (Group HBO) and conventional therapy group (Group Convention), and the cure rate of both groups and the timing and courses of HBO therapy were compared.

Results:
The cure rate of Group HBO (81.5%) was obviously higher than that of Group Convention (54.5%) ($p<0.05$). For the patients who received HBO therapy within 3 days, 3~7 days or over 7 days after the initial operation, the cure rate was respectively 92.3%, 88.9% and 40.0% ($p<0.05$). Besides, for patients who respectively underwent less than 5 sessions, 5~10 sessions or over 10 sessions of HBO therapy, the respective cure rate was 75.0%, 78.6% and 88.9% ($p>0.05$).

Conclusions:
Adjunctive HBO therapy could increase the cure rate of comminuted tibial fracture. If patients received HBO therapy timely after surgical procedures, the greater probabilities of complete healing can be achieved, which could be also expected to increase when more sessions of HBO treatments were prescribed. Although this is a retrospective study, it properly encourages further basic animal experiments and prospective clinical trials.

Key words: Hyperbaric Oxygen, Tibial Comminuted Fracture

P-34 TREATMENT OF CLOSTRIDIUM SEPTICUM AORTITIS WITH HYPERBARIC OXYGEN (HBO)

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Introduction:
42 cases of Clostridium septicum aortitis are described in medical literature (1,2). Mortality is reported to be as high as 50%. Antimicrobial therapy consists of penicillin G, clindamycin or vancomycin in case of allergy to penicillin. Surgical therapy is recommended even though the timing is under discussion (1). The value of adjunct therapies as hyperbaric oxygen is unknown.

Case presentation:
An 81-year old female was admitted to hospital complaining of severe pain between the scapulae with sudden onset. Comorbidities were a non-insulin dependent diabetes, arterial hypertension and chronic renal insufficiency. Further examination showed an enlarged aortic arch, gas bubbles inside the aortic wall on computed tomography and general signs of bacterial infection. Clostridium septicum was detected in blood cultures. No underlying malignancy was detected (3,4).
After deterioration of the patient's general condition, she was intubated and ventilated. Bacteriological examination revealed bloodstream infection with Clostridium septicum. Surgical intervention was not recommended by a cardiothoracic specialist at this time. The patient was admitted to our hyperbaric facility where she was treated three times with 300 kPa of oxygen pressure for 90 minutes and twice with 240 kPa for 90 minutes on consecutive days according to our standard protocol for gas-gangrene (5). After HBO therapy, the patient improved markedly. The following CT-scan showed complete resolution of gas formation inside the aortic wall. Unfortunately, the patient developed ventilator associated pneumonia followed by multiple organ failure two days later and the family decided not to expand intensive care, respecting the documented last will of the patient.

Discussion:
Our case is the first description of HBO as an adjunct therapy aiming to reduce gas formation, bacterial growth and exotoxin release in the treatment of clostridial aortitis. HBO can safely be performed even in patients requiring intensive care treatment.

Key words: Clostridium septicum, gas gangrene, aortitis, HBO.

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P-35 NECROSIS AFTER HYALURONIC ACID FILLER AND HYPERBARIC OXYGEN THERAPY

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Introduction:
Necrosis as a result of vascular compromise due to accidental intravascular injection, is the most severe complication of aesthetic treatment with dermal fillers. The complication is uncommon but with the increasing popularity of dermal fillers, the prevalence may increase. This report aims to provide more insight of the clinical significance of hyperbaric oxygen therapy to treat this vascular complication.

Patients & methods:
A 55-year old woman who underwent dermal filler injections with crosslinked hyaluronic acid, was admitted for hyperbaric oxygen therapy (HBOT) after developing necrosis due to vascular compromise. Right after injection of 1ml HA filler in the nose and upper lip, discoloration of the upper lip occurred. The lip as well as the columella and aperture pyriformis were treated with a hyaluronidase injection (150U), as the filler might have ended up intra-arterial in these areas. After a follow up of 6 days, the patient appeared at the cosmetic clinic with 3 small wounds, two on the right vermillion border of the upper lip and one on the right ala. Slough on the vermillion of the lip indicated infection of the wound, whereupon Augmentin® treatment was started. To prevent permanent sequelae, the patient was referred to the hyperbaric oxygen department of our hospital.

Results:
HBOT started 2 days after wound development. The patient was treated with 21 sessions of oxygen at 2.4 atmospheres absolute pressure for 90 minutes, twice a day. The outcome was positive as the wounds recovered completely without scarring.

Conclusion:
Vascular compromise following dermal fillers are rare, but may increase with the popularity of dermal fillers. The complication needs direct treatment as it could lead to facial necrosis. There is little data about treatment of this complication with hyperbaric oxygen therapy. We reported a case in which HBOT was applied successfully to treat dermal ischemia after use of HA fillers.

P-36 HYPERBARIC OXYGEN THERAPY AWARENESS WITHIN A DOCTOR POPULATION

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Introduction:
The aim of this study was to identify the level of awareness regarding the European Committee of Hyperbaric Medicine (ECHM)-accepted indications for the use of hyperbaric oxygen therapy (HBOT) amongst doctors practising in Malta.

Method:
All doctors licensed to practice in Malta were asked to complete a questionnaire including demographics and background information. Scores regarding local HBOT service provision and ECHM-approved HBOT indications (yes & no answers with negative scoring) were performed. 153 replies were obtained during the 4-week recruitment period. Chi-square tests and logistic regression models were used to obtain the statistical results using IBM SPSS version 20.

Results:
85 participants were male, whereas 68 were female. Age ranged between 20 to 64 years.
Doctors who referred patients for HBOT scored significantly better than those that never referred patients ($p=0.018$). Consultants scored noticeably better than more junior doctors ($p<0.0001$). Those who attended a lecture in baromedicine scored better than doctors who had not ($p=0.009$).
Doctors who claimed to be aware of the indications within their specialty are more likely to refer patients for HBOT in the future ($p<0.0001$). Hospital-based doctors and doctors who performed scuba diving were also more likely to refer patients for HBOT in the future ($p=0.038$) and ($p=0.016$) respectively. Doctors working in hospitals were significantly more likely to answer correctly than doctors working in the community ($p=0.002$).
Our results showed that 152 respondents out of 153 think they should be more informed on this service.

Conclusion:
Baromedicine is a specialty that remains at the sideline of most doctors' awareness. We plan to conduct outreach lectures so that the medical profession will be more familiar with the indications for HBOT prior to re-auditing.

Key words: Hyperbaric Oxygen Therapy, Survey, Awareness

P-37 THE ADVANTAGES AND DISADVANTAGES OF DIFFERENT STRATEGIES USED TO CREATE SHAM HYPERBARIC OXYGEN THERAPY.

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Introduction:
Research performed in hyperbaric medicine has been subject to controversy: with the growing demand for evidence based medicine, hyperbaric oxygen therapy (HBO) has been criticized for delivering too little high-quality research. Especially, well-executed randomized (sham) controlled trials (RCT's) are needed for both established indications as well as indications with currently low evidence. This review identifies strategies in creating sham therapy and discusses the advantages and disadvantages of each strategy.

Methods:
A systematic database search for sham-controlled trials on HBO therapy in the past 25 years was conducted. Control treatment was considered sham if patients were blinded to their allocation and took place in a hyperbaric chamber, with no restrictions regarding pressurization or oxygen levels. Studies involving children or only one session of HBO were excluded. Information on treatment profile and complications was extracted from eligible articles.

Results:
34 trials were identified. Three main strategies for sham therapy can be distinguished: treatment at the same pressure as the actual HBO treatment using 21% oxygen (6 trials), treatment at the same pressure but on a lower oxygen concentration of 7.5-10.5% (7 trials) and treatment at a lower pressure using 21% oxygen (17 trials). 17 trials provided information on complications: in general, the incidence of adverse events did not differ distinctively between groups. Myopia was reported more for HBO (25 events) than sham (6 events). Using lower pressure for sham therapy resulted in less barotrauma of the ears in comparison to actual HBO treatment (23 versus 90 times). No oxygen toxicity or decompression sickness was reported.

Conclusions:
Based on the identified trials, mild complications can arise in each form of sham treatment, with no reports of serious events. Using 21% oxygen and minimal pressurization resulted in the least amount of barotraumas. It is therefore the preferred strategy for sham treatment in hyperbaric medicine.

Key words: Hyperbaric Oxygen Therapy, Methodology, Sham Treatment, Complications, Placebo.

P-38 CARBON MONOXIDE POISONING – A TRANSREGIONAL COHORT ANALYSIS

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Introduction:
In Germany, acute carbon monoxide (CO) poisoning causes >500 deaths/year. The number of hyperbaric chambers to provide hyperbaric oxygen is limited. Larger cohort analysis about type and severity of CO poisoning are needed to improve quality of care in Germany.

Methods:
This retrospective cohort study included all patients with CO poisoning treated at the transregional Hyperbaric Emergency Center (HEC) of Wiesbaden (Germany). Paramedic protocols, medical records of the first treating hospital and records of HEC were analyzed. Sociodemographic data, sources of the poisoning, initial symptoms and development of symptoms in relation to different COHb-levels were analyzed. Temporal time spans between first hospital treatment and secondary treatment in HEC were analyzed to draw conclusions regarding process management.

Results:
254 men and 164 women (mean age 38±19; range 4-94) were treated between January 2013 and December 2016. The first blood gas analysis (n=418) revealed mean COHb-levels of 15±10% (range 0.3-75%). Unspecific symptoms like headache (n=210), dizziness (n=197), nausea (n=174), syncope (n=152) and vomiting (n=53) dominated. Main reasons for CO intoxications were smoke inhalation (n=85), water pipe smoking (n=61), and attempted suicide (n=65). 293 out of 418 patients were treated in a primary hospital before being transported to HEC. Time span between first blood gas analysis and analysis in HEC was 2:27±3:35 hours and COHb was reduced from 17±11 to 7±6% respectively.

Conclusion:
Reasons for CO poisoning and symptoms are varying. The high number of severe CO poisoning in a single center underlines the importance of quick and adequate diagnosis of patients with potential CO intoxication. Process workflows in hospitals have to be optimized to eliminate CO in the bloodstream as quickly as possible and minimize CO poisoning effects.

Key words: Carbon Monoxide, Hyperbaric Oxygen, Poisoning

P-39 ACTUAL PROBLEMS OF CARBON MONOXIDE INTOXICATION: RETROSPECTIVE STUDY

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Chair of Biomedical Sciences, Medical Faculty, University of Ostrava, Ostrava, Czech Republic [2]

Introduction:
The aim of the current study was to analyze the circumstances, results and side effects of HBOT in patients with carbon monoxide (CO) intoxication in our treatment centre.

Methods:
A retrospective study included the analysis of the medical records of patients treated for CO intoxication from 1st January 2014 to 31st January 2015 to obtain relevant demographic data, sources, time of intoxication, selected laboratory results, complications, final outcome. A questionnaire survey was also carried out to obtain some informations and preventive measures including the installation of autonomous CO detectors.

Results:
In the study period total of 56 patients with CO intoxication were treated (30 men - 53.6%, 26 women - 46.4%). The mean age was 32.8 years (range 4-91). The most common cause of intoxication was gas heater (27 cases, 48%). The mean interval to start HBOT was 3 hours. The mean COHb value was 24.5% (range 6.6-40). The mean BE was -3.3 mmol/l. The mean number of HBOT sessions was 1.7 (range 1-4). The final outcome was favorable in 54 cases (96.4%). Hospital mortality was 1.8%. 48 questionnaires out of 54 have been obtained (89%). 14 persons (29%) were installed CO detector inside of residence.

Conclusions:
There is important requirement for continuous interdisciplinary cooperation between some medical specialties especially in specific conditions such as pregnancy, children, serious intoxication associated with the cardiac arrest on the scene.

Key words: Carbon Monoxide Poisoning, Carboxyhemoglobin, Hyperbaric Oxygen

P-40 RECOVERY OF BILATERAL IDIOPATHIC SUDDEN SENSORINEURAL HEARING LOSS AFTER DELAYED HYPERBARIC OXYGEN TREATMENT

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Introduction:
Idiopathic Sudden Sensorineural Hearing Loss (ISSHL) is an idiopathic hearing loss of at least 30 dB across at least three frequencies occurring over a 72-hour period, with an estimated incidence of 2-20 cases per 100000 people per year. Unilateral hearing loss is more frequent, with only up to 3 percent of bilateral cases. Current treatment recommendations involve systemic or intratympanic glucocorticoids, antiviral agents and, where available, hyperbaric oxygen therapy (HBOT) - grade 1 recommendation. Prognosis is variable depending on several factors, including a shorter time to treatment after symptom onset, and is worse for patients without a recovery within three to four months.

Methods:
A 57-year old female teacher, ASA II, with an history of 102 days of bilateral ISSNHL without associated symptoms came to the Hyperbaric Unit. She was initially treated in a peripheral hospital without a hyperbaric unit where she did laboratory testing and an MRI with no relevant findings. She was treated with systemic corticotherapy and vasodilators, with minor audiometric and clinical improvement. She voluntarily came to the unit after learning about the possibility of HBOT. 15 USNT9 mod sessions were prescribed.

Results:
The patient was re-evaluated after 14 sessions and had bilateral audiometric and clinical improvement, particularly on the left side, after which she was proposed for an additional 3 sessions. No further improvement was noticed.

Discussion:
ISSHL is a disabling condition, and its prognosis can be improved with early diagnosis and treatment. Even though HBOT is recommended on the first 14 days after symptom onset, a later use can still dramatically improve patient's quality of life.

Key words: Hyperbaric Oxygen Therapy, Idiopathic Sudden Sensorineural Hearing Loss

P-41 HYPERBARIC OXYGEN THERAPY IN ORTHOPEDICS & TRAUMATOLOGY - A CASE REPORT

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Introduction:
Hyperbaric Oxygen Therapy (HBOT) has been successfully used as an adjunct treatment of several conditions in Orthopedics and Traumatology such as Gustilo IIIb open fractures and possible infectious complications namely anaerobic soft tissue infections. These are still life-threatening infections that must be promptly recognized and aggressively treated.

Methods:
Male, 40-year-old, admitted in the Emergency Room after suffering a mountain bike accident presenting a tibial pilon open fracture - Gustilo-Andersen IIIb - highly contaminated. Early surgical debridement, osteotaxis of the fracture and intravenous broad-spectrum antibiotics were prescribed. On the 4th post-operative day there were signs of a sudden and rapidly progressive infection. Once more extensive surgical debridement of the necrotic muscle and other soft tissue was performed resulting in a 2x3cm bone exposure. The patient was referred to the Hyperbaric Unit and was prescribed with USNT9 mod. Meanwhile with the worsening of the symptoms and a high suspicion of a gaseous gangrene, intensive HBOT was prescribed (8x120' at 2.8 ATA). Afterwards 29 USNT9mod sessions were completed. On the 12th postoperative week there were wound conditions for the first of the several surgeries that allowed definitive treatment of the tibial fracture. 10 months later all the operative wounds were closed, the bone had healed and the patient was walking and practicing sports.

Discussion:
We present a case of successful multidisciplinary treatment of a Gustilo IIIb open fracture of the tibial pilon complicated by gangrene. HBOT was a key treatment element in improving wound healing times and containing the infection contributing for the avoidance of member amputation.

Conclusion:
Here is an example of HBOT clinical effectiveness in a severe trauma injury complicated by mixed bacterial anaerobic infection.

Key words: Open Fracture, Anaerobic Infection, Hyperbaric Oxygen Therapy

P-42 HYPERBARIC OXYGEN TREATMENT OF IDIOPATHIC SUDDEN SENSORINEURAL HEARING LOSS - 6 YEAR RETROSPECTIVE STUDY

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Introduction:
Idiopathic Sudden Sensorineural Hearing Loss (ISSHL) is an idiopathic hearing loss of at least 30 dB across at least three frequencies occurring over a 72-hour period, with an estimated incidence of 2-20 cases per 100000 people per year. Current treatment recommendations involve systemic or intratympanic glucocorticoids, antiviral agents and, where available, hyperbaric oxygen therapy (HBOT) – a grade 1 recommendation. Prognosis is variable depending on several factors.

Methods:
We present a retrospective study with data collected from the informatic process (Glintt® and PICIS®) between 2010 and 2016. Patients were referred to the hyperbaric unit by the Ear, Nose and Throat Service, according to clinical and audiometric criteria. HBOT was prescribed using USNT9mod. With the new protocol from 2012 no more than 20 sessions are prescribed. Data collected: age, sex, number of HBOT sessions, number of days from symptom onset and referral to HBOT, clinical improvement, cardiovascular (CV) co-morbidities, pure tone average (PTA) pre- and post-HBOT. A descriptive statistical analysis was performed using SPSS® software.

Results:
Of an initial 38 patients, 35 were included – 18 males, 17 females, mean age 50±14 years. 14 (40%) patients had CV co-morbidities. Mean time from symptom onset to HBOT was 26.1±26.5 days (n=28) and mean time from referral to HBOT (n=35) was 7.8±14.11 days. 34 patients were treated with systemic glucocorticoids and the mean number of HBOT sessions was 18±5.5. There was a mean PTA improvement of 13.8±15.63 dB post HBOT with 10 (28%) successful treatments according to Furuhashi's criteria, and 13 (37%) patients reporting a clinical improvement.

Discussion:
Our results are in agreement with the state-of-the-art literature. A protocol review should be undertaken in order to improve ISSHL medical treatment and a better registry of patients' medical data.

Key words: Hyperbaric Oxygen Therapy, Idiopathic Sudden Sensorineural Hearing Loss

P-43 EMERGENCIES IN HYPERBARIC MEDICINE: ONE-YEAR ACTIVITY REPORT

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Service de Chirurgie Cardiaque, Hopital Militaire de Tunis / Faculté de Medecine de Tunis, Tunis, Tunisia [2]

Introduction:
Clinical reports have found HBOT an excellent adjunctive therapy for a variety of pathologies. Many of the clinical indications involve emergent conditions justifying the 24h availability of the treating team.
The aim of our study is to analyze the emergent pathologies treated in our facility over the last year.

Methods:
It is a retrospective, descriptive study involving all the patients treated for an emergency condition in the hyperbaric center of the military hospital of Tunis during the year 2016.

Results:
Over the last year, 333 patients were treated for an emergency indication in our facility, which represents 63% of our overall activity. These patients were divided in two groups: immediate emergencies: 68.5%, delayed emergencies: 31.5%. There were 153 men and 180 women. Mean age was 33±19 years. Previous medical history was found in 27.6 % of the patients. Diabetes was the most frequent pathology (14% of patients). 57% of patients were assigned from emergency departments. Only 11.7% of them were military. Immediate emergencies involved 228 patients: 220 cases of CO poisoning, 7 cases of DCI and one case of cerebral air embolism (CAE). Delayed emergencies concerned 105 patients: 63 cases of sudden deafness, 35 cases of necrotizing soft tissue infections and 4 cases of mediastinitis. Treatment protocols were either one or several HBOT sessions according to different treatment tables: B18 (2.8 ATA) for DCI and CAE; OHB 2.5 ATA in all the other cases. HBOT related complications were reported in 18 cases: middle ear barotraumas (17 cases). Favorable outcome was obtained in 265 patients.

Conclusion:
Approved indications for HBOT which are considered to be an emergency are well established by different scientific societies. Besides specifically treating diving accidents, air embolism and CO poisoning, HBOT should be rapidly included as an adjunctive therapy in several treatment protocols.

P-44 EPIDEMIOLOGY OF PREGNANT WOMEN TREATED FOR CARBON MONOXIDE POISONING

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Introduction:
Carbon monoxide poisoning is a frequent accident that may occur during pregnancy resulting in fetal mortality or neurological impairments related to anoxic lesions.
The aim of our study is to analyze the epidemiologic profile of pregnant women treated with HBOT for CO poisoning.

Methods:
It's a retrospective descriptive study involving all the pregnant women treated for CO poisoning in the Hyperbaric Center of the Military Hospital of Tunis during 7 years: from November 2010 until December 2016.

Results:
During this period, 199 pregnant women (mean age was 28±5 years) were treated. Most accidents happened in February. The accident occurred during the first pregnancy in 150 patients especially in the first trimester for 80 of them. Water heating devices were the major cause of CO poisoning. All patients reported neurological complaints: headache in all victims, dizziness in 75 patients and loss of consciousness in 59 cases. Four patients reported diminished fetal movements. Fetal ultrasound performed prior to HBOT in 19 cases showed no abnormalities. Mean delay for HBO treatment was 4 hours. Immediate outcome was favorable in all patients. Eight women suffered from middle ear barotrauma and in 3 cases, treatment could not be achieved because patients had claustrophobia.

Conclusion:
Epidemiological profile of pregnant women victim of CO poisoning is similar to the standard population. Hyperbaric Oxygen therapy should be offered in all cases of CO poisoning, especially if there are maternal symptoms during exposure. A strategy for long term follow up should be established at least for the severe cases.

Key words: Carbon Monoxide Poisoning, Pregnancy, HBOT, Epidemiolgy

P-45 FORGOTTEN TOURNIQUET: TREATMENT OF AN ISCHEMIC FINGER WITH HYPERBARIC OXYGEN THERAPY

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Introduction:
A tourniquet at the base of a digit is widely used to ensure minimal bleeding during surgery. When not removed, ischemia can cause severe tissue damage.
By hyperoxygenation, vasoconstriction (which reduces edema) and an anti-inflammatory response, hyperbaric oxygen (HBO) is shown to have positive effects in treating hypoxic injuries such as crush injury, compartment syndrome, burns and frostbite. In this case report we discuss a patient with an ischemic finger caused by a forgotten tourniquet. Literature search on Pubmed showed no similar cases.

Materials and methods:
Using HBO, we treated a 73-year old patient with an acute ischemic injury after the removal of a gout tophus was complicated by a forgotten tourniquet. The tourniquet was removed 48 hours after surgery, she was initially treated with escharotomy to relieve the edema of the skin. Her progress was monitored by photographs.

Results:
72 hours after removal of the tourniquet the patient was treated with HBO (80 minutes of 100% oxygen at 2.5 ATA). During and immediately after this first session finger discoloration from dark purple to red was seen, showing a direct increase in oxygenation. Because of this effect she received twice daily treatment for 2 days, followed by once daily treatment, with a total of 15 continuous sessions. Edema reduced and after initial skin and nail detachment, her wounds granulated well. Motor skills and sensibility improved. After 3-month follow-up she had regained full use of her finger, with only mild decreased sensibility in her distal phalanx.

Conclusions:
The patient showed a direct effect of HBO on oxygenation in the ischemic finger, as well as improved wound healing and motor function. Based on this case and other publications on traumatic ischemic injuries we suggest this therapy to be considered in treating a tourniquet induced ischemic trauma.

Key words: Hyperbaric Oxygen Therapy, Acute Ischemic Trauma, Ischemic Finger, Forgotten Tourniquet, Surgical Complications.

P-46 THE FEASIBILITY OF CONCURRENT HYPERBARIC OXYGEN THERAPY (HBOT) AND INTRATYMPANIC STEROID APPLICATION (ITS)

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Introduction:
Hyperbaric oxygen therapy (HBOT) and intratympanic steroid application (ITS) are beneficial as salvage therapy for therapy-refractory sudden sensorineural hearing loss (SSNHL). We used both treatments at the same time to determine hearing improvements and feasibility of the concurrent use of HBOT and ITS.

Methods:
Sudden sensorineural hearing loss (SSNHL) is defined as a loss of hearing of 30 dB or more over at least three contiguous frequencies in the pure tone audiometry (PTA).
We prospectively identified seven consecutive cases with idiopathic, noise or barotrauma-induced SSNHL. Most of the patients presented after unsuccessful corticoid treatment with the symptoms persisting for up to 10 weeks. All patients then received bilateral paracentesis and ITS (dexamethasone with hyaluronic acid) and were immediately transferred to the HBO chamber (2.5 ATA for 2x30 min for each session). Thresholds were determined by PTA before the start and after finishing the salvage treatment.

Results:
Cases series of 8 patients (25-62yrs): 5 patients experienced unilateral SSNHL and 3 presented bilateral hearing loss and tinnitus after severe noise trauma. Hearing thresholds improved in all patients after the combination of ITS and HBOT and also Tinnitus – if newly occured - revealed. Quantifying audiograms for all cases after salvage treatment are provided for both ears.

Conclusions:
A synergistic effect of ITS and HBOT has been proposed in order to explain the gain of threshold: on the one side, steroids reduce inflammation in the inner ear that may be contributing to hearing loss, on the other side, HBOT increases the intracochlear aiding in the recovery of hearing. However, based on our experience, the hearing recovery may be achievable even if the onset of SSNHL was several weeks to months ago, if the patients were attributed to HBOT immediately after ITS. In addition to the synergistic effort in reducing edema in the inner ear, we assume that HBOT changes the permeability of the round window membrane allowing increased influx of steroids into the perilymph, especially into the basal turn of the cochlea, where dexamethasone levels can be expected to be the highest. This may explain the recovery of hearing not only in the low frequencies but also in the high frequencies that are more refractory to recovery treatment.
Further studys are needed to determine the best dosis for drug delivery to the cochlear at hyperbaric oxgenation.

Keywords: Concurrent Hyperbaric Oxygen Therapy, Intratympanic Steroid Application, Sudden Deafness, Sudden Sensorineural Hearing Loss, Tinnitus

P-47 INCIDENCE OF OXYGEN TOXICITY DURING HYPERBARIC OXYGEN THERAPY: INFLUENCE OF AIR BREAKS AND TREATMENT COMFORT. RETROSPECTIVE ANALYSIS OF 69406 TREATMENTS IN A SINGLE HYPERBARIC CENTRE.

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Introduction:
Oxygen toxicity seizures (OTS) are a known complication of hyperbaric oxygen therapy (HBO). The incidence of OTS has been variously reported and appears to be related to both duration and pressure of exposure, in addition to individual susceptibility factors.

Methods:
For this retrospective study, all HBO treatments of the first 20 years of operation of the Brussels Military Hospital Centre for Hyperbaric Oxygen Therapy were reviewed. For each treatment, the following were analyzed: pressure, oxygen exposure, OTS occurrence, air breaks and chamber type.

Results:
Overall, 69406 treatments were performed and 38 OTS occurred (1/1826 or 5.47 per 10000 exposures).
17467 exposures were done in a small, uncomfortable diving chamber (Comex1500, Comex, France) and 51939 exposures were given in a large, modern chamber (Haux Starmed 2800, Haux, Germany). In the old chamber, 14 OTS occurred (1/1247 or 8 per 10000), in the new chamber 24 OTS (1/2164 or 4.62 per 10000).
The two commonest treatment profiles were: 3x25min O_2 at 2.5ATA (with 2x5min air break), used 18675 times (profile A) and 70min O_2 at 2.5 ATA (no systematic air breaks), used 48604 times (profile B). Exhaled O_2 concentration was systematically measured in all patients to ensure proper mask fit. For profile B, air breaks of 5min halfway the session were given to patients with suspected OTS susceptibility factors.
Profile A had 16807 exposures in the old and 1868 exposures in the new chamber. Profile B had 48604 exposures in the new chamber. For profile A, 13 OTS occurred in the old chamber (1/1292 or 7.73 per 10000) and 1 in the new chamber (1/1868 or 5.35 per 10000). For profile B, 23 OTS occurred (1/2113 or 4.73 per 10000). In all OTS patients, individual susceptibility factors were identified.

Discussion:
Profile B was instated based on a preliminary risk-benefit analysis, failing conclusive literature evidence that it would be less safe with regards to OTS incidence. The incidence of OTS almost decreased by half in the new chamber while using a profile without systematic air breaks. We postulate that patient comfort and the continuous presence of a caring inside attendant, as well as other stress reducing measures are important factors in OTS prevention. In our experience, the absence of systematic air breaks did not increase OTS incidence. Continued attention as to the possibility of OTS in patients with suspected susceptibility factors, as well as optimalisation of HBO treatment comfort is an important factor.

P-48 A SURVEY STUDY ABOUT INFORMED CONSENT OF PATIENTS TREATED IN HYPERBARIC OXYGEN TREATMENT CENTER: MEDICOLEGAL APROACH

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Introduction:
The purpose of this study is to determine the level of perception of the information provided during the informed consent process to potential Hyperbaric Oxygen Therapy (HBOT) patients and the effect of this information on decision making.

Methods:
The study was conducted with face-to-face interviews at the Department of Underwater and Hyperbaric Medicine. Surveys included questionnaires that measured the perceived level of information provided before HBOT, and the questionnaire on contradictions in the scale, enrolled form, socio-demographic data, diagnosed disease, comorbidities, standardized mini-mental test.

Results:
A total of 56 patients were enrolled in the study. The mean age of the patients was 46.4 ± 13.5 (min: 17 - max: 72) and 75% (n = 42) of them were males. The answers to the question "who gives the best decision about your treatment" were replied as: "physicians" (53.6%), “myself" (37.5%) and “my family" (37.5%). 23.2% (n = 13) of the patients answered yes to the question "did you receive help while reading the informed consent form". 5% of college graduates and 33% of high school and below education level patients reported to have received assistance in reading the informed consent form which has been found to be statistically significant ($p < 0.05$).

Conclusion:
Our study showed that patients who applied for HBOT were satisfied of the informed consent procedure, and their educational background had an impact on their understanding of the information. Providing assistance for patients to better understand the informed consent form and utilizing various materials to provide information on treatment options and medications used during treatment could be beneficial for patients with high school and below educational levels. HBOT may be an important contributor to patient autonomy in informed consent research, which will be done using different information materials and methods, in larger patient groups.

P-49 CONCENTRATION DEPENDANT ANTI- AND PRO-OXIDATIVE EFFECTS OF VITAMIN C IN PBMCS UNDER OXIDATIVE STRESS

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Introduction:
Vitamin C (VC) is a potent antioxidant able to reduce oxidative damage e.g. induced by reactive oxygen species (ROS). Similarly, VC is decreased by oxidative agents in organism. There is also evidence for pro-oxidative capacity of VC. In the present study, anti- and possibly pro-oxidative effects of VC under oxidative stress were determined ex vivo inducing ROS by means of hyperbaric oxygen (HBO).

Methods:
Freshly isolated PBMCs (peripheral mononuclear blood cells) from male healthy subjects (20-30ys; n=34) were exposed to 500kPa HBO in an experimental pressure chamber after 3hrs of pre-incubation with 0, 50, 100, 200, 400µM VC. To exclude or calculate any further influencing factors, possible effects of pH-changes, cell-washing, pre-incubation in incubator (37°C, 20%O_2, 5%pCO_2) and leaving VC in cell suspension while exposure to HBO on DNA damage or cell viability were evaluated, the methods of analysis adjusted. DNA fragmentation as parameter for oxidative damage was measured by the alkaline Comet Assay, calculating the percentage of cells with visible DNA damage in a binary scoring system of 200 PBMCs. Pre- and post-experimental cell viability was determined by trypan blue staining.

Results:
The percentage of cells with DNA-damage was reduced after incubation with lower concentrations of VC (50, 100 and 200 µM), and there was only a marginal difference, if VC was left in the cell suspension during HBO or washed out before. In the 400µM VC-experiment percentage of DNA-fragmented cells was significantly increased, if VC was left in cell suspension. The percentage of damaged cells showed no significant changes, if VC was washed out before HBO.

Conclusion:
VC at maximal or doubled maximal physiologic serum concentration reduces DNA damage induced by hyperbaric oxygen ex vivo, whereas VC in concentrations as high as four times maximal serum level increases DNA damage in PBMCs exposed to hyperbaric oxygen.

Key words: Hyperoxia, DNA Damage, Vitamin C, Antioxidative, Pro-oxidative

P-50 TREATMENT OF MALIGNANT OTITIS EXTERNA WITH HYPERBARIC OXYGEN: REVIEW OF A SINGLE HYPERBARIC CENTER EXPERIENCE

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Introduction:
Malignant otitis external (MOE) is an aggressive and potentially life-threatening infection of the soft tissues of the external ear and surrounding structures, quickly spreading to involve the periostium and bone of skull base. In the 7th European Consensus Conference on Hyperbaric Medicine it was considered as "Other indications" condition for treatment with hyperbaric oxygen (HBOT). However, in the 10th Consensus Conference, this disease was considered as a "non-indication" for HBOT. The aim of this study was to evaluate the effectiveness of HBOT in MOE treatment.

Methods:
Retrospective and observational study of patients with MOE treated in our centre. Staging of the disease was made according to the clinicopathological classification system.

Results:
From March 1998 to November 2016, 17 patients were referred. All completed HBOT, except one who died of heart attack. Average age was 71 years and only one patient (5%) was female. 7% patients were on stage 1 of the disease at the time they were referred, 20% in stage 2, 7% in stage 3a, 13% in stage 3b and 53% patients were in stage 4. 7 (41%) patients had VII nerve palsy and 3 (17%) patients had multiple nerve palsy. Average length of symptoms of disease was 7 months (maximum 11 months). All patients had diabetes and one patient had also lymphoma. The most common pathogen identified was *Pseudomonas aeruginosa.* Average number of sessions was 33, there were no fatalities due to MOE and all patients were considered free disease after HBOT.

Conclusion:
HBOT was well tolerated and revealed to be a helpful adjuvant treatment in MOE. Despite the late stage of disease, HBOT might had contributed to avoid fatal disclosure in some patients. Therefore, further studies with larger series would be recommended. According to our data, HBOT should be considered for MOE treatment.

Key words: Malignant Otitis External, Hyperbaric Oxygen

P-51 ANGIOGENESIS AND HYPERBARIC OXYGEN: AN EXPERIMENTAL STUDY ON ANGIOGENESIS WITH THE CHICK EMBRYO CHORIOALLANTOIC MEMBRANE.

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Introduction:
The study of angiogenesis is one of the most active areas of research in recent years.
The conditions of territorial and systemic tissue hypoxia, significantly affect the metabolism placing itself at the base of many of ischemic, inflammatory, immunological, infectious and neoplastic pathologies as well as alteration of the physiological processes of tissue repair through direct and indirect actions on angiogenesis.
The effects of the action mechanism of hypoxia have been extensively investigated in clinical and experimental trials, but less known are the effects that hyperoxia conditions and most of oxy-hyperbarism have in biological processes.
Hyperbaric Oxygen Therapy (HBOT) is increasingly applied in different areas of medical practice. The oxy-hyperbarism effects are not well understood in cancer malignancy. One unique feature of cancer is the presence of hypoxic regions that are insensitive to conventional therapies. It is possible to alter the hypoxic state and produce reactive oxygen species for improve treatment outcome by HBOT.

Methods:
In the present study, we determined the effects of HBOT on angiogenesis, that characterizes cancer progression, by using the chick chorioallantoic membrane (CAM) in vivo assay. CAMs were exposed to 2.0 ATA (atmospheres absolute) for a 30-min of Hyperbaric Oxygen on the 6th day of incubation (ED6) and on the 7th day of incubation (ED7). On the 11th day of incubation, CAMs were excised from eggs, fixed and analysed using APERIO ImageScope software. HBOT outcomes were evaluated quantifying the volumetric area occupied by blood vessels and calculating the number of blood vessels ramifications.

Results:
Results have demonstrated that CAMs treated at ED6 and ED7 had a significative higher CAM vascularization and an increased number of blood vessels ramifications compared to untreated CAMs (ED6=63.33±2.517 and ED7=57.67±5.508 vs CTRL=34.67±2.517). These results show that HBOT induces an angiogenic response in the treated CAMs through a classic sprouting mechanism.

Key words: Hyperbaric Oxygen Therapy (HBOT), Angiogenesis, Vasculogenesis, CAM.

P-52 EFFECT OF HYPERBARIC OXYGEN THERAPY IN THE CONTROL OF ACUTE SEPSIS INFLAMMATORY PROCESSES IN RATS

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Introduction:
Sepsis is a complication caused by the intense and potentially fatal response to an infection, which can lead to tissue damage, organ failure and death. It is difficult to predict, diagnose and treat. Patients who develop sepsis are at increased risk of complications and death and face higher health care costs and longer treatment. It is therefore urgent to develop new strategies to manage the symptomatology of this condition and even its treatment. In this regard, hyperbaric oxygen therapy demonstrates interesting potential.

Methods:
Animals were divided into three groups of twelve animals (Control, Sepsis, Sepsis + HBO). Sepsis was induced by intraperitoneal injection of purified LPS. The onset of sepsis was accompanied by clinical and behavioural assessment. HBO was administered at 3 ATA pressure with 100% O2 inhalation for 60 minutes, 3 hours after sepsis was induced. One hour after, blood samples were collected and serum cytokines (IL-1, IL-6 and TNFα), AST, ALT, ALP, SOD, urea, creatinine and albumin were determined by enzyme immunoassay, and total proteins and CK by direct / indirect spectrophotometric methods. The experiments were approved by the local ethics committee (ORBEA UP).

Results:
Significant differences were found for the Sepsis and Sepsis + HBO for parameters: AST (291.67±44.86 vs 218.92±59.80), ALT (322.50±82.84 vs 63.23± 12,78 ALP (258.87±57.04, vs 157.42±38.11) Urea (117.54±19.12 vs 28.55±11.41), TNFα (223.01±30.70 vs 79.27±20.01), IL-6 (6.55±1.01 vs 5.62 ±1.15) and Creatinine (1.00±0.01, 0.41±0.01).

Discussion and Conclusion:
The results suggest that HBO therapy has great potential in the prevention of sepsis-related damage, particularly in generalized renal, hepatic and muscular dysfunction and injury, as evidenced by the normalization of the serum levels of the main enzymatic and inflammatory mediators of sepsis.

P-53 EXPERIMENTAL USE OF FLOW CYTOMETRY FOR VIABILITY DETERMINATION OF PATHOGENIC BACTERIA AFTER HYPERBARIC OXYGEN EXPOSURE.

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Introduction:
Soft tissue infections represent a multidisciplinary medical issue with possible unfavorable outcome for a patient quality of life. Nowadays, Hyperbaric Oxygen Therapy (HBOT) is used as adjuvant therapy to support wound healing. Despite extensive clinical evidence of beneficial effects of HBOT in soft tissues infections treatment, there is no *in vitro* model available to be used to study mechanism of HBOT effects on bacteria. The aim of this study was to evaluate a use of flow cytometry for bacteria viability determination after hyperbaric oxygen exposure (HBO).

Methods:
Cultures of selected pathogenic bacteria were exposed to 2.8 ATA of oxygen for 45, 90 and 120 min respectively and viability was assessed with flow cytometry after propidium iodide and tiazoline orange staining.

Results:
Flow cytometry data analysis showed different susceptibility of bacterial strains to HBO. Cultures of *Actinomyces israelii* and *Staphylococcus aureus* did not show any alteration of bacteria viability and morphology after HBO compared to *Klebsiella pneumoniae* culture. Cultures of *Pseudomonas aeruginosa, Streptococcus oralis* and *Escherichia coli* showed HBO dose dependent changes. A microbiological mixture containing *Actinomyces israelii*, *Actinomyces naeslundii* and *Streptococcus oralis* mirrored the changes observed in *Streptococcus oralis* after HBO.

Conlusions:
Flow cytometry represents a favorable method to determine bacteria viability and morphological changes after HBO. This is especially important when bacteria might be in viable but not cultivable state. Our data also suggest that HBO bacteria alteration in more susceptible strains might be able to trigger impairment also in bacteria's more resistant to HBO.

Key words: Hyperbaric Oxygen Therapy, Flow Cytometry, Bacteria, Infection

P-54 EFFECT OF HYPERBARIC OXYGENATION (HBOT) ON FEMORAL CONDYLE OSTEONECROSIS (ONK).

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Introduction:
ONK, similarly to other osteonecrosis (ON), starts from an ischemic event that may cause subchondral bone tissue death and joint collapse requiring invasive and costly procedures. Hyperbaric oxygen therapy (HBOT) is a non-invasive therapy which leads to improved oxygenation of ischemic areas. It has been recently demonstrated to improve clinical conditions in avascular necrosis of the femoral head (AVNF). We recently demonstrated in AVNF patients that HBOT promotes neovascularization and pro-inflammatory cytokine modulation by increasing osteoprotegerin (OPG) plasmatic levels, but not Receptor activator of nuclear factor kappa-B ligand (RANKL) levels. This present study evaluates the efficacy of HBOT in an ONK patient series.

Methods:
This is a retrospective study comprised of 38 ONK patients (29 male, 8 female; mean age ±1 SD: 54±14) who were treated daily, from Monday to Friday, with 3 cycles of 20 HBOT (82 minutes at 2.5 ATA and 100% O2) interrupted by one or two months rest and for an average of 67.9±15 sessions. Magnetic resonance imaging (MRI) was performed before HBOT, one year and 7 years after the end of treatments. Oxford Knee Score (OKS) were recorded before HBOT, at the end of treatments and at 7 years follow up.

Results:
After the first cycle of HBOT, 86% of patients experienced improvement in their Oxford Knee Score (OKS), 11% worsened, and 3% didn't change. All patients improved in OKS after 2-3 cycles. First follow up MRI showed patient's edema at the femoral condyle had resolved for all patients, but one. On long term follow-up, the MRI appearance was completely normal in all cases.

Discussion:
HBOT is beneficial in ONK, as demonstrated in AVNF, showing clinical improvements after 20-40 treatments. However, radiological improvements required at least 60 sessions.

Key words: Femoral Condyle Osteonecrosis, Hyperbaric Oxygenation, Knee Osteonecrosis (ONK)

P-55 CLINICAL ACTIVITY IN THE HYPERBARIC CENTER OF TUNIS: ONE YEAR REVIEW

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Introduction:
Hyperbaric oxygen therapy (HBOT) is breathing 100% oxygen while under increased atmospheric pressure. Indications to this treatment are based on the physiologic mechanisms of HBOT. Our study aims to assess the different pathologies managed in our hyperbaric facility through one year.

Methods:
It is a retrospective descriptive study including all the patients treated at the only hyperbaric facility that exists in Tunisia which is the hyperbaric center of the military hospital of Tunis through the year 2016.

Results:
In the past year we received 712 consultants, 526 of them were enrolled for hyperbaric treatment. They were 292 men and 234 women. The mean age was 40 ± 22 years. At least one medical condition is found in 269 patients: diabetes and hypertension (169 and 105 cases). Military patients were 93. All the others were civilians. Emergency structures provided 188 patients while surgery departments addressed 159. Overall number of HBO sessions was 6164 thus approximately 12 sessions per patient. Treatment indications were mostly emergency conditions in 333 patients. Carbon monoxide poisoning was the main pathology with 220 patients. Chronical conditions were treated in 193 patients. Diabetic foot ulcer was the dominant indication (106 patients). Protocol treatment of one daily session at 2.5 ATA for 90 min was used for 443 patients. HBOT related complications were reported by 51 patients: Middle ear barotraumas in 37 patients. Ultimate outcome was favorable in 349 patients.

Conclusion:
The hyperbaric center of Tunis, founded since 2008, is experiencing a growing clinical activity. Treatment indications spectrum is enlarging in both medical and surgical fields. Technical and human resources should be increased to fulfill the increasing demands.

Key words: Hyperbaric Oxygen Therapy, Management , Assessment

P-56 HYPERBARIC OXYGEN FOR THE TREATMENT OF FOURNIER GANGRENE: (TUNISIAN EXPERIENCE)

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Introduction:
Fournier's gangrene (FG) is a necrotizing fasciitis of the genitalia that is associated with high morbidity and mortality. Treatment consists of surgical debridement, antibiotic therapy and adjuvant hyperbaric oxygen (HBO) therapy.
The aim of this study is to analyze the epidemiology of FG and assess the effectiveness of HBO.

Methods:
The records of all patients suffering from Fournier's gangrene, from 2012 to 2016, treated at the hyperbaric center of the military hospital of Tunis were reviewed. Data concerning clinical presentation, complications and outcomes were analyzed.

Results:
During the five past years, we treated 70 patients diagnosed with Fournier's gangrene. They were 52 men and 11 women. The mean age was 57±12 years. Thirty-nine patients (55.7%) were not retired yet. Half of them were smokers. The most frequent systemic illness was diabetes mellitus. No previous medical history was reported in 25.7% of the cases. The location of FG was in the anorectal region in 53 patients. Five patients were critical. Only nineteen had a diverting colostomy. HBO was started 2 days after first surgery for most patients. The average number of HBO sessions was 13; we performed one daily session for 60 patients. The other 10 received two daily treatments. Outcome was favorable in 55 patients: reduced necrosis and significant budding allowing skin graft. Four patients died. Minor complications due to HBOT were reported in 3 cases.

Conclusion:
Treatment of Fournier’s gangrene involves several modalities: aggressive resuscitation, broad-spectrum antibiotic therapy, early colostomy and repeated surgical intervention. Early adjunction of HBO therapy can help stop the progression of gangrene, prevent septic shock, and increase survival rates.

Key words: Fournier's gangrene, Hyperbaric Oxygen Therapy (HBOT)

P-57 SAFETY MANAGEMENT OF HYPERBARIC FACILITY

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Introduction / Background / Objectives:
As with all facilities there is a requirement for good management and leadership. The position of Safety Manager in Europe has been realized by cooperation between EBAss & ECHM. There is a need to develop a formal standardized management team within European hyperbaric facilities. The medical director has a right to have a competent individual as part of this team who can be relied on to ensure safety. This person will be ultimately responsible to the medical director.

Methods:
EBAss/ECHM/ECB aim is harmonization of educational standards throughout Europe, this could be argued to be especially necessary for Hyperbaric Units due to specialist safety issues. As with all roles it is not enough to be properly qualified and experienced, the individual must maintain their competence by undertaking Continuing Professional Development (CPD) in advanced hyperbaric safety.

Results:
The Safety Manager will need to be experienced to the specific unit they are to manage; there will of course be a requirement for significant induction training at the specific unit. The Safety Manager will ensure there is no confusion between personnel, responsibilities and boundaries, they will support the Medical Director as a reliable, competent individual.

Discussion / Conclusion:
A competent Safety Manager should have a good basic hyperbaric education (ECB Certification, ECHCO, ECHRN or equivalent), have recent experience in the hyperbaric field (5 years +) as well as additional specific and recognized advanced education related to the hyperbaric field. The Safety Manager will need to be qualified in the fields of Risk Assessment/Management and Quality Assurance, they must also have a good working knowledge for management of infection control.

Key words: Safety, Management, Risk, Quality, Training.

P-58 EFFECTS OF HYPERBARIC OXYGEN PRECONDITIONING ON CARDIAC-VASCULAR FUNCTION OF HUMAN EXERCISE DURING ACUTE AND CHRONIC HYPOXIC EXPOSURE

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Objectives:
To investigate the effects of hyperbaric oxygen preconditioning on cardiac-vascular function of human exercise during acute and chronic hypoxic exposure.

Methods:
8 healthy male subjects who stayed at simulated altitude of 4000m in a hyperbaric-hypobaric chamber and 6 subjects who residenced at high altitude 3800m for 6 to 24 months participated individually in our experiments. We recorded their stroke volume, left ventricular ejection time, heart rate, inter-beat interval and cardiac output during the physical load before and after the hyperbaric oxygen preconditioning for 3, 5 and 7 days.

Results:
After 7d HBO preconditioning the SV significantly increased after physical load in high altitude hypoxia compared with the control groups ($p<0.05$). After 5d HBO preconditioning the LVET significantly prolonged after physical load in high altitude hypoxia compared with the control group ($p<0.05$). At the same time, HBO preconditioning showed positive effects on inter-beat interval extension, heart rate reduction and cardiac output enhancement.

Conclusions:
Hyperbaric oxygen preconditioning could significantly strengthen human cardiac-vascular function by improving hemodynamics during the physical load during acute and chronic hypoxic exposure. Hyperbaric oxygen preconditioning can effectively reduce fatigue, improve labor efficiency of human body at high altitude hypoxic area.

Key words: HBO, Hypoxic Exposure, Exercise, Cardiovascular Function

P-59 MULTIFACETED MITIGATING EFFECTS OF HYPERBARIC OXYGEN THERAPY IN ALZHEIMER DISEASE MOUSE MODELS

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Objectives:
Alzheimer's disease (AD) is the most common form of dementia in the elderly. In addition to its main pathological signatures like accumulation of extracellular amyloid plaques and intracellular neurofibrillary tangles, AD is associated with hypoxia, neuroinflammation and diminished blood flow. Hyperbaric Oxygen Therapy (HBOT), the medical administration of 100% oxygen at environmental pressures greater than 1 atmosphere absolute (ATA), has been used successfully in the treatment of other neurological conditions. Here, we investigated the effects of HBOT on two different mouse models of AD pathology, the 3xTg-AD and 5xFAD mouse models.

Methods:
17-month old 3xTg-AD mice were exposed to HBOT at 2 ATA for 60 minutes per day for 14 days while 6 month old 5xFAD and wt mice were exposed to HBOT at 2 ATA for 60 minutes per day, 5 days a week for 1 month (20 treatments).
Subsequently to HBO treatment, a behavioral test battery was performed and histological analysis of hippocampal slices was conducted.

Results:
HBOT ameliorated cognitive deficits of both 3xTg-AD mice and 5xFAD AD mice. Moreover, HBOT reduced significantly the presence of hypoxia and amyloid burden in the hippocampal area in both models. In the 3xTg-AD mice, HBOT attenuated neuroinflammation by reducing astrogliosis, microgliosis and secretion of proinflammatory cytokines. In the 5xFAD, HBOT induced neurogenesis and enhanced survival of adult-born granule cells.

Conclusions:
These findings demonstrate that HBOT acts via multifaceted mechanisms including increase in neurogenesis and reduction of inflammation to affect brain functionality and may present a novel therapeutic intervention of AD.

Key words: Hyperbaric Oxygen, Alzheimer, Neuroplasticity, Brain

P-60 EFFECT OF NORMOBARIC HYPEROXIA ON ACUTE LYMPHOBLASTIC LEUKEMIC CELL LINES IN VITRO

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Introduction/Objectives:
The effect of excess reactive oxygen species on cancer cells is controversially discussed. Therefore, this study aimed to evaluate alterations in basic molecular mechanisms induced by exposure to normobaric hyperoxia in acute lymphoblastic leukemic (ALL) cell lines.

Methods:
An ALL B- and T-cell line were cultured according to standard operating procedures and exposed to a single bout of 65% oxygen for a long- or a short-term interval.
DNA-fragmentation was assessed using single cell gel electrophoresis (comet assay), protein expression of oxidative stress markers, nitric oxide synthases (NOS) and pro- and anti-apoptotic proteins was assessed using western blot, electrophoretic mobility shift assay, or enzyme-linked immunosorbent assay. High-resolution respirometry was applied for assessment of respiratory adaptation within the mitochondrial electron transfer system (ETS).

Results:
The level of oxidative stress in both cell lines was increased after normobaric hyperoxia, in the B-cell with an immediate response after exposure but fast recovery and in the T-cell with a delayed response up to 24 hours after the stimulus. Impaired mitochondrial function of the intact cells could not be found, however, ambivalent changes in the activities of complexes I and II of the ETS were discovered. Apoptosis induction and modified regulation of nitric oxide synthase expression was solely found in the T-cell.

Discussion/Conclusion:
While the B-cell was affected immediately but recovered within 24 hours and only showed a transient activation of apoptotic pathways, the T-cell responded later with DNA-fragmentation, apoptosis induction after long-term exposure, and complex regulation of NOS expression. Looking at the very different effects of normobaric oxygen on molecular and metabolic alterations in the two examined cell lines, it does seem inadequate to propose a general oxygen exposure scheme for acute lymphocytic leukemia. Sensitisation of each cell line will have to be considered individually.

Key words: Normobaric Hyperoxia, Leukemia, DNA-fragmentation, Mitochondria, Apoptosis

P-61 USEFULNESS OF BIOPHOTONICS TECHNOLOGY IN THE TREATMENT OF CHRONIC WOUNDS OF THE LOWER LIMBS

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Introduction:
Biophotonic Technology is based on PhotoBioModulation (PBM), which is the photons ability to activate photoreceptors inside cells and tissues, molecular cascades able to modulate many aspects in cellular biology.
The interaction between biological tissues and light is mediated by photoreceptors, both at cellular and intracellular levels, that induce specific signal transduction pathways recruiting transcription factors, thereby resulting in a concerted regulation of gene expression and contributing to the therapeutic effects of PMB on wound healing.
In the inflammatory and proliferative phase stimulates fibroblasts, keratinocytes, osteoblasts, chondrocytes. In addition, it induces the synthesis of the matrix.
In the maturation phase, it promotes tissue regeneration and improves its quality by preventing apoptosis, improving blood circulation, increasing ATP and cAMP.
The biological reactions caused by exposure to PMB induce nitric oxide production (NO), a potent vasodilator, analgesic and anti-inflammatory agent, and TGF-beta growth factors (favoring the migration of keratinocytes, endothelial cells and fibroblasts) and VEGF (which stimulates the formation of new blood vessels and improves skin scarring). These are the same mechanisms of Hyperbaric Oxygen Therapy so it is possible to hypothesize a positive synergy between them.

Method:
Twelve patients were candidates, for a total of twenty-eight ulcers with varying aetiology: 15 rheumatic, 5 venous, 8 traumatic.

Results:
The most responsive ulcers are the rheumatic ones (all ulcers were improved and five of them were healed), probably in relations to the high anti-inflammatory power of PMB. Traumatic ulcers were found to be marginally responsive, venous ulcers were the least responsive.

Conclusions:
PMB therapy has a beneficial effect in vasculitic ulcers in terms of healing time and in the management of chronic pain. PMB facilitates all fases of the wound repair process. The patient's quality of life is improved.
Robust studies are needed to confirm the effectiveness of PMB in relation with HBOT.

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