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European Underwater & Baromedical Society
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EUBS
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Abstract & Conference Book





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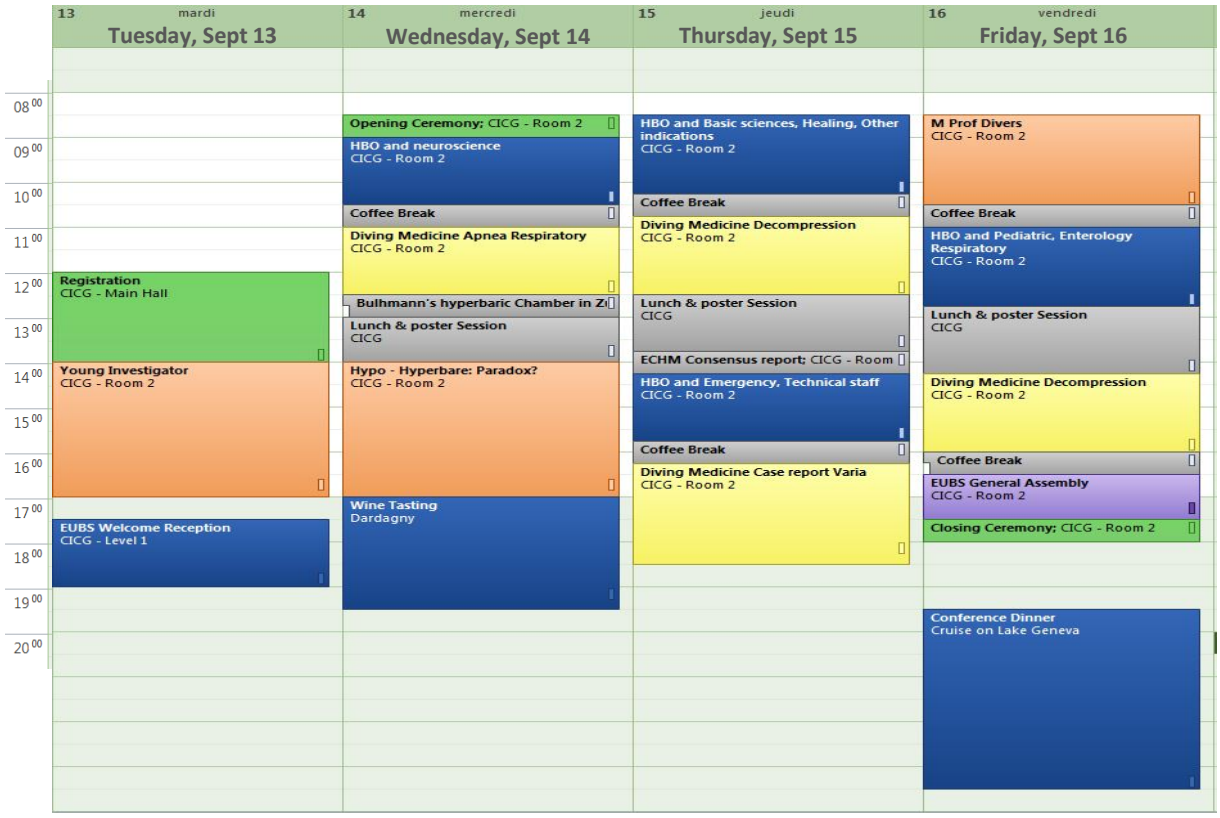
SCIENTIFIC PROGRAMME OVERVIEW



SCIENTIFIC PROGRAMME

Time	Author	Title	No.	Page
Tuesday, September 13, 2016				
12:00 - 17:00	Registration open & Set-up Industry Exhibition			
14:00 - 17:00	**Special Session: Young Investigator**			
	Moderators: C. Balestra & J-E. Blatteau			
14:00 - 14:45	S. De Maistre	Relevance of a rat model in the assessment of decompression sickness treatments: clinical examination and drug kinetics.		
14:45 - 15:15	B. Degraz	RCT: a difficult task in HBO		
15:15 - 15:45	S.L. Blogg	How to write a paper: the Editor's point of view		
15:45 - 16:15	C. Balestra	Grants - how does that work?		
16:15 - 1700	J-E. Blatteau - C. Balestra	Research protocols and statistics (placebo etc…)		
17:30 - 19:00	**Welcome Reception**			
Wednesday, September 14, 2016				
07:00 - 17:00	Registration open			
08:30 - 09:00	Opening Ceremony EUBS ASM 2016			
09:00 - 10:30	**Scientific Session I: HBO and Neuroscience** **Moderators: F. Assal, A-S. Eichenberger**			
	A. Hadanny	HBOT can induce angiogenesis and neuroplasticity in TBI patients	O-01	10
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	S. Ýlbasmiþ	Long term evaluation of retinal artery occlusion patients that were applied hyperbaric oxygen treatment	O-04	13
	P. Bothma	Myringotomy or tympanostomy tubes: always required for patients with artificial airways undergoing HBOT?	O-05	14
	P. Lafère	A prospective study of anaesthesia's effects on Eustachian tube compliance to prevent ear barotrauma in ICU ventilated patients treated with HBOT	O-06	15
10:30 - 11:00	Coffee Break			
11:00 - 12:45	**Scientific Session II: Diving Medicine Apnea Respiratory** **Moderators: B. Barberon and J-Y. Berney**			
	Xuhua Yu	Bubble-induced endothelial microparticles promote endothelial dysfunction	O-07	16
	G. Vandenhoven	Maximal voluntary ventilation and pulmonary function after breath hold dive training program	O-08	17
	O. Castagna	Inspiratory loading during SCUBA exertion leads to extravascular lung water (EVLW) accumulation	O-09	18
	R. Hesthammer	The effects of normobaric hyperoxia on exhaled nitric oxide, tetrahydrobiopterin and phenylalanine	O-10	19
	O. Castagna	Extravascular lung water (EVLW) accumulation is more important when using a back rebreather compared to an open-circuit	O-11	20
	N. Schellart	Influence of the wet diving suit on standard spirometry	O-12	21

12:30 - 12:45	**C. Wolfel**	**Buhlmann's hyperbaric chamber in Zurich**		
12:45 - 14:00	Lunch Break & Poster presentation			
14:00 - 17:15	**Special Session: Hypo-Hyperbaric: Paradox?** **Moderators: C. Sartori, C. Marti, M-A. Magnan**			
	S. Tourreau *Professional freediver*	Free diving movie		
	P. Robach *Physiologist, ENSA*	Training at high altitude, improving performance?		
	F. Damilano *Mountain Guide*	Everest 2014 movie hypobaric effects when being at the top of the world		
	F. Beker	Use of recompression chamber at high altitude for frostbite		
	Coffee Break			
	S. Popof, G. Duperrex	Case report: severe frostbite treated by HBO		
	M-A. Magnan	"SOS gelures": France-Suisse interreg programme		
	C. Gaudet-Blavignac	International Frostbite Registry: IFR presentation		
17:15 - 19:30	**Geneva Wine Tasting**			

Thursday, September 15, 2016

08:30 - 10:15	**Scientific Session III: HBO and Basic sciences, Healing, Other indications** **Moderators: B. Pittet, H. Vuagnat, M. Gelsomino**			
	S. Klapa	Acute hyperoxic exposure induces a TH1 mediated immune response with simultaneously increased numbers of regulatory T and B cells	O-13	22
	D. Lévigne	Hyperbaric oxygen therapy promotes wound closure and perfusion in ischemic and hyperglycemic conditions, independently of myofibroblast differentiation	O-14	23
	P. Longobardi	Cost impact of hyperbaric oxygen therapy for diabetic foot ulcers	O-15	24
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	A. Mitrovic Jovanovic	Hyperbaric oxygenation therapy in infertility patients - 17 years of experience	O-18	27
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	I. Eftedal	The peripheral blood transcriptome reflects leukocyte subtype fractions and activity: applications in diving	O-22	31
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	F.Z. Kiboub	The outcome of saturation diving on endothelial function and biomarkers of vascular health in professional offshore divers	O-25	34
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	D. Mathieu	**Report from the Consensus Conference on Hyperbaric Medicine (Lille, 2016)**	O-27	36
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	E. Parmentier-Decrucq	Gas embolism after cardiovascular surgery: is it important to obtain diagnosis confirmation before hyperbaric treatment?	O-30	39
	E. Niyibizi	Delayed hyperbaric oxygen therapy for air emboli after open heart surgery: report and review of a success story	O-31	40
	C. Gaio-Lima	A retrospective study of the treatment of burned patients in the hyperbaric unit	O-32	41
	N. Lansdorp	Documentation and monitoring of patient information in European hyperbaric facilities	O-33	42
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16:15 - 18:30	**Scientific Session VI: Diving Medicine - Case reports, varia** **Moderators: C. Camponovo, Wei-Gang Xu, J-E Blatteau**			
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	J.D. Schipke	Corpse of recreational diver found in the hotel room: sickle cell anaemia - a case report	O-36	45
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	K. Doenyas-Barak	Immersion induced fluid redistribution of more than 3 % of total body weight - prospective, randomized, crossover clinical trial in anuric hemodialysis patients	O-42	51

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	T. Mavrostomos *World Recordman*	The history of a dive at 701m		
	J. Lelievre *Quality Manager*	VisioConference PdG: Professional Diver in saturation		
	M. Gelsomino *HMD Class IIIc*	Medical assistance in saturation		
	J-P. Imbert	Decompression of saturation		
	J. Kot	Decompression of saturation: how to accelerate in emergency?		
10:30 – 11:00	Coffee Break			
11:00 – 12:45	**Scientific Session VII: HBO and Pediatric, Enterology, Respiratory** **Moderators: F. Heritier, J. Schmutz, M. Pellegrini**			
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	D. Cavalheiro	Hyperbaric oxygen therapy for the management of late-onset haemorrhagic cystitis after allogeneic bone marrow transplantation – A cohort of paediatric patients.	O-45	54
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Location:	**Amphithéatre des Polycliniques, HU Genève**	
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09:10 - 09:25	C. Pellegrini	Polizia Lacuale and Seepolizei
09:30 - 09:40	D. Cialoni	SkiScubaSpace
09:45 - 10:10	G. Thomas	CADDY
10:15 - 10:30	M. Pieri	GF/DCI: Incident analyses (database)
10:35 - 10:45	G. Thomas	Don't get lost
10:45 - 11:05	**Coffee Break**	
11:05 - 11:25	P. Scherrer	Legal
11:30 - 11:50	F. Burman	Diving Safety Officer
11:55 - 12:10	W. Welslau	Aging Divers
12:15 - 13:15	**Lunch break**	
13:15 - 13:40	C. Balestra	Research: Physiology and Ergonomics
13:45 - 14:10	J. Kot	Technical diving and medical issues
14:15 - 14:25	D. Cialoni	Taravana
14:30 - 14:55	A. Marroni	Diving Research Advances
15:00	Closure	

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O-01 HBOT CAN INDUCE ANGIOGENESIS AND NEUROPLASTICITY IN TBI PATIENTS

Amir Hadanny[1], Sigal Tal[2], Yair Bechor[1], Gregory Fishlev[1], Yaakov Bergan[1], Mony Friedman[1], Shai Efrati[1]

[1] Sagol Center for Hyperbaric Medicine and Research, Asaf Harofeh Medical Center, Zerifin, Israel
[2] Radiology department, Asaf Harofeh Medical Center, Zerifin, Israel

Introduction:
Recent clinical studies in patients with chronic neurological impairment due to stroke or TBI present evidence that hyperbaric oxygen therapy (HBOT) can induce neuroplasticity in patient with metabolic/anatomic mismatch in their brain imaging. Till now, the mechanisms responsible for the neuroplasticity were demonstrated only in pre-clinical studies. Accordingly, there is a real need for sensitive accurate brain imaging that can demonstrate the changes in humans.
The objective of this study was to assess the neurotherapeutic effect of HBOT in patients suffering from prolonged post-concussion syndrome (PPCS) due to TBI using novel brain microstructure imaging and to compare to the neurocognitive functions.

Methods and materials:
Fifteen patients suffering from PPCS due to TBI treated with 60 daily HBOT sessions. Imaging evaluation was performed using perfusion MRI (dynamic contrast enhanced susceptibility) and Diffusion Tensor Imaging (DTI) protocol, in addition to FLAIR, T2 and SWI sequences. Cognitive evaluations were performed by objective computerized battery (NeuroTrax).

Results:
HBOT was initiated 6 months to 27 years (10.3±3.2 years) from injury. After HBOT, DTI analysis showed significantly increased fractional anisotropy values and decreased mean diffusivity in both white matter and grey matter. Grey matter structures included frontal, temporal, parietal areas and the caudate nucleus. White matter structures included centrum semiovale, uncinate fassiculus, cingulum, fornix, superior and inferior longitudinal fasciculus and the splenium. In addition, the cerebral blood flow and volume were significantly increased.
Clinically, HBOT induced significant improvement in the global cognitive scores. The most prominent improvements were seen in executive functions, attention, information processing speed and visual spatial processing indices.

Conclusions:
The mechanism by which HBOT induce brain neuroplasticity can be demonstrated by highly sensitive perfusion MRI+DTI. HBOT can induce cerebral angiogenesis and improved both white and grey microstructure indicating regeneration of nerve fibers. The micro structural changes correlated with the neurocognitive improvements.

Keywords:
TBI, PCS, Post-concussion syndrome, Traumatic brain injury, Angiogenesis, MRI, HBOT

O-02 HBO TREATMENT STRATEGY FOR CNS INFECTIONS; REGISTRY RESEARCH NEEDED

Folke Lind

Karolinska Institutet, Stockholm, Sweden

Introduction:
Central Nervous System (CNS) infections in or adjacent to the brain or spinal cord are rare but grave medical challenges often leading to instant and repetitive surgical interventions and intense long-term antibiotic treatment. Karolinska University hospital have two decades of experience using adjunctive hyperbaric oxygen treatment (HBOT) to help cure such acute or subacute spontaneous, posttraumatic or postoperative infections.

Methods:
After ethical approval long-term outcome was assessed for various patient groups and the results were published as retrospective consecutive patient cohort studies. Postoperative neurosurgical infections in adults (Larsson et al, Neurosurgery 2002;50:287-96), Postoperative infections in children with neuromuscular spine deformity (Larsson et al, Eur Spine J 2011. 12:2217-22); Spontaneous brain abscesses in adult patients (Bartek et al 2016). A study on infected neuromodulatory implants is on the way.

Results:
Infection eradication was seen in all patients, many times without the need for reoperations and removal of infected bone/acrylic flaps or foreign bodies.

Discussion:
HBOT show promising clinical results in acute life-threatening brain abscesses as well as in cranial or spinal biofilm infections resilient to conventional antimicrobial therapy. It is safe. It is an alternative to standard surgical removal of infected bone flaps, acrylic flaps and other foreign material. It improves outcomes in our patient population and can probably reduce overall costs. It is especially useful in more complex infections involving multiple risk factors, such as radiotherapy, multiple reoperations, antibiotic resistant microorganisms etc.

Conclusion:
HBOT seems to have an important role in the neurosurgical armamentarium for cranial and spinal infections. Randomized investigational studies are not realistic. International translational research cooperation is required to clarify the potential of HBOT as an adjunctive treatment strategy in the war against vicious and difficult to treat microbial pathogens. The relative effectiveness of HBOT and the indications defining when HBO treatment is superior to other modes of therapy will need to be defined in observational registry studies.

Keywords:
Brain abscess, Spinal empyema, Implant, Cranioplasty, Hyperbaric oxygen therapy

O-03 CENTRAL RETINAL ARTERY HYPOXIA CAN BE REVERSED BY HBOT: CLINICAL MARKER FOR EFFICACY

Amir Hadanny[1], Amit Maliar[1], Yair Bechor[1], Gregory Fishlev[1], Yaakov Bergan[1], Mony Friedman[1], Isaac Avni[2], Shai Efrati[1]

[1] Sagol Center for Hyperbaric Medicine and Research, Asaf Harofeh Medical Center, Zerifin, Israel
[2]Opthalmology Department, Asaf Harofeh Medical Center, Zerifin, Israel

Introduction:
Central retinal artery occlusion (CRAO) is a common ophthalmologic condition with a poor prognosis. The maximum time window for effective treatments that reverse the anoxic damage is unknown and wide variability is expected between patients. Hyperbaric oxygen therapy (HBOT) can reverse retinal ischemia by increasing dissolved oxygen delivery to the ischemic tissue until spontaneous or assisted reperfusion occurs.
The primary objective of this study was to evaluate the effect of HBOT and determine possible markers for irreversible retinal damage, using the largest cohort to date of non-arteritic CRAO patients without cilioretinal artery (CRA) sparing.

Methods and Materials:
Retrospective analysis of 225 patients treated with HBOT for CRAO in 1999-2015. Out of which 128 fulfilled inclusion/exclusion criteria: age>18, symptoms< 20 hours and best-corrected visual acuity (BCVA) worse than 0.5 logMAR. Patients with patent CRA, iatrogenic CRAO or branch retinal artery occlusion were excluded.

Results:
The mean time delay from symptoms to treatment was 7.8±3.8 hours. The BCVA after HBOT compared with the baseline showed significant mean improvement of 0.526±0.688, from 2.14±0.50 to 1.61±0.78 ($p<0.0001$). The proportion of patients with clinically meaningful visual improvement was significantly higher in patients without cherry-red spot (CRS) compared to patients with CRS at presentation (86.0% vs 57.6%%, $p<0.0001$). The percentage of patients with final BCVA better than 1.0logMAR was also significantly higher in patients without CRS than patients with CRS at presentation (61.0% vs 7.1%, $p<0.0001$). There was no significant difference in the time delay to treatment in the two subgroups ($p=0.06$). The treatment was found to be safe and only 7 patients (5.5%) had minor, reversible adverse events.

Conclusions:
HBOT is an effective treatment for non-arteritic CRAO while infarction/CRS hasn't formed. The fundus findings, rather than the time delay from symptoms onset, should be used as the most important predictor of HBOT success.

Keywords:
CRAO, Central retinal artery occlusion, HBOT, Cherry red spot, Efficacy

O-04 LONG TERM EVALUATION OF RETINAL ARTERY OCCLUSION PATIENTS THAT WERE APPLIED HYPERBARIC OXYGEN TREATMENT

Savas Ýlbasmiþ [1], Erdinc Ercan[2]

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[2] *Eskisehir Military Hospital Hyperbaric Oxygen Treatment Clinic, Eskisehir, Turkey*

Introduction:
Retinal artery occlusion represents an ophthalmologic emergency. Painless loss of monocular vision is the usual presenting symptom of retinal artery occlusion (RAO). Ocular stroke commonly is caused by embolism of the retinal artery, although emboli may travel to distal branches of the retinal artery, causing loss of only a section of the visual field. Immediate intervention improves chances of visual recovery. Hyperbaric oxygen treatment (HBOT) is one of the treatment modalities for RAO. HBOT may be beneficial if initiated within 2-12 hours of onset of symptoms. Objective of this study was to evaluate the usefulness of HBOT on the patients who had applied to our clinic for HBOT with a RAO diagnose.

Material and Methods:
16 patients were included in this study for a 3 years period those were applied HBOT with RAO diagnosis. HBOT sessions of these patients had been started as quick as possible soon after they had arrived. Also all patients had been started medication by ophthalmologists that who had sent them. To evaluate the outcome of the treatment the patients were called with telephone and ophthalmology clinic control examinations were obtained. Patients were asked survey questions about their visual ameliorations before and after HBOT.

Results:
Mean initiation duration of patients to get HBOT was about 28 hours. Only one patient was initiated treatment after 13 days from the event and no visual amelioration was recorded. Within this patient, no visual amelioration was recorded for 2 more patients. Among the other 13 patients, 3 had 80% and more, 3 had 50-79% and 7 had below 50% visual amelioration. 11 of 13 patients had peripheral visual field amelioration.

Discussion:
With the medical treatment immediate intervention of HBOT was considered a useful treatment modality for RAO. The visual amelioration of the visual fields was considered especially in the peripheral vision rather than central vision.

Keywords:
Retinal artery occlusion, Hyperbaric, Vision

O-05 MYRINGOTOMY OR TYMPANOSTOMY TUBES: ALWAYS REQUIRED FOR PATIENTS WITH ARTIFICIAL AIRWAYS UNDERGOING HBOT?

Basil Al Omari[1], Pieter Bothma[2,3]

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[2] *Department of Anaesthesia and Clinical lead for the East of England Hyperbaric unit, James Paget University Hospitals, Gorleston, United Kingdom*
[3] *London Hyperbaric unit, Whipps Cross University Hospital, Leytonstone, United Kingdom*

Introduction:
Hyperbaric oxygen therapy (HBOT) is associated with an increased risk of barotrauma to the tympanic membrane and middle ear. Failure to equalise during the treatment increases the risk of barotrauma hence this will be an issue in unconscious patients. Our units manage 90% of all ventilated patients in hyperbaric chambers in the UK. Due to various logistical reasons we cannot always obtain immediate assistance with myringotomies. We will present our results.

Objectives:
The aim of this study is to compare the outcome for those patients who receive myringotomy with or without tympanostomy tube insertion and those who did not receive any intervention. Inclusion criteria: Patients who are unconscious, and mechanically ventilated.

Methods:
Patients will be stratified in 2 groups:

1. will be admitted to the HBOT institution at a suitable time where they will be assessed by both ENT and Hyperbaric physician and undergo myringotomy
2. attend at a time or a unit where the above ENT service is not available. They will undergo their HBOT without myringotomy. All patients will have further otological follow-up 3-4 months post treatment.

Results:
Participating units will continue their regular practice, collect their results and submit to the study steering group. After analysis, results will be presented at a subsequent EUBS meeting as well as our scientific journals.

Discussion:
Traditional textbook teaching indicates the need for myringotomies in unconscious patients needing HBOT. This is clearly not the standard of practice everywhere in the world. We occasionally have to decide between the need for urgent HBOT or waiting for myringotomies.

Conclusions:
More robust evidence is required and can only be done by multinational collaboration. We would like to invite all units treating unconscious patients with HBOT to contact us to indicate your interest to participate.

Keywords:
Hyperbaric, Unconscious, Barotrauma, Myringotomy, Ventilated

O-06 A PROSPECTIVE STUDY OF ANAESTHESIA'S EFFECTS ON EUSTACHIAN TUBE COMPLIANCE TO PREVENT EAR BAROTRAUMA IN ICU VENTILATED PATIENTS TREATED WITH HBOT.

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Objective:
The most common complications of hyperbaric oxygen therapy (HBOT) are related to pressure changes on gas-containing cavities. Therefore, inability to auto-inflate the middle ear may result in transient or permanent hearing loss. However, it seems that ear barotrauma (MEB) does not develop more often in ICU ventilated patients than in ambulatory patients. This might be explained by deep sedation of these patients. Therefore, the aim of this study is to determine whether anaesthesia and/or neuromuscular blockade can influence Eustachian tube function.

Methods:
40 patients who were undergoing surgery under general anaesthesia were enrolled in this prospective study. The Eustachian tube function was evaluated by tympanometric tests, which were done three times: before induction (Baseline), after injection of opioids/propofol and after injection of neuromuscular blocking (NMB) agents once full blockade was achieved.

Results:
There were no differences in ear volume (p=0.19) and ear pressure (p=0.07) during the different measurements. Compared to baseline, there is a significant increase in compliance after the combined injection of opioids and hypnotic agents (24±7.13%, p=0.001). However, injection of NMB agents does not further improve compliance (23±8.9%, p=0.011).

Discussion:
The findings of this trial suggest that the administration of hypnotic drugs associated with opioids improve Eustachian tube compliance. Therefore, it may have favourable prophylactic effects of MEB in ICU ventilated patients scheduled for HBOT.

O-07 BUBBLE-INDUCED ENDOTHELIAL MICROPARTICLES PROMOTE ENDOTHELIAL DYSFUNCTION

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Introduction:
Decompression sickness (DCS) is a systemic pathophysiological process caused by intravascular bubbles. Endothelial microparticles (EMPs) are established markers reflecting competency of endothelial function and vascular biology. Here, we investigated the effects of bubble-induced EMPs on endothelial function in vitro and vivo.

Material and Methods:
Rat pulmonary microvascular endothelial cells (PMVECs) were isolated and stimulated by nitrogen bubbles, then bubble-induced EMPs were collected and incubated with normal PMVECs. Cell livability and apoptosis were detected using Cell Counting Kit-8 assay and Annexin V FITC/PI double staining, respectively. Cell permeability and pro-inflammatory cytokines including s-ICAM-1 and s-VCAM-1 were determined by electric cell substrate impedance sensing and ELISA, respectively. Intracellular nitric oxide and reactive oxygen species production were analyzed by immunofluorescence. In vivo study, after injection of bubble-induced EMPs, circulating endothelial cells (CECs) counting and pro-inflammatory cytokine measurements were involved in evaluating endothelial dysfunction.

Results:
Bubble stimulus resulted in a significant increase of EMPs release. Bubble-induced EMPs significantly decreased cell livability and increased cell apoptosis in normal PMVECs. Moreover, bubble-induced EMPs also induced abnormal increase of cell permeability and over-expression of pro-inflammatory cytokines, accompanied by increased intracellular ROS production and decreased NO production. These adverse effects on normal PMVECs caused by bubble-induced EMPs were remarkably suppressed when EMPs were lysed by surfactant FSN-100. In addition, intravenous injection of bubble-induced EMPs caused significant elevations of CECs and serum pro-inflammatory cytokines.

Conclusion:
Our results demonstrated that bubble-induced EMPs can mediate endothelial dysfunction in vitro and vivo, which can be attenuated by EMPs abatement strategy. These data expanded our horizon of the detrimental effects of bubble-induced EMPs, which may contribute to endothelial dysfunction in DCS.

Keywords:
Bubble, Endothelial microparticle, Decompression sickness

O-08 MAXIMAL VOLUNTARY VENTILATION AND PULMONARY FUNCTION AFTER BREATH HOLD DIVE TRAINING PROGRAM

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Introduction – Background:
Breath hold diving (BHD) can modify the respiratory physiology. It can be useful for training of athletes but also for revalidation of patients. This pilot study aims to investigate impact of BHD training on beginners as well as safety.

Materials and Methods:
An epidemiological questionnaire about tobacco, breath hold diving and SCUBA diving history was submitted to all breath hold divers of the RCAS Diving Club, Belgium.
Spirometric tests including Maximal Voluntary Ventilation (MVV) were performed before and after a BHD S1 training. Bronchial obstruction reversibility was performed in order to detect asthmatics.

Results:
The breath hold divers (n=35) replying to the questionnaire had a mean age of 44 (±13) years, a sex ratio M/F=3.4, 5.7% active smokers (vs 13 % and 20 % in respective SCUBA divers and general population in Belgium). 14% were passive smokers, 26% ex-smokers (vs 25% in Belgium) and 69% were non-smokers. All were also SCUBA divers. Adverse events rate was 1/952 breath hold dives and 1/16,799 SCUBA dives.

MVV was significantly greater than the predicted value in all divers (n=13) and increased significantly for 7/13 subjects in a 4-8 S1 training sessions with an asymptomatic significant decrease in FEV1/FVC values still within normal range in all BHD divers.

Discussion – Conclusion:
BHD divers were mainly non-smokers compared to SCUBA divers and a general population in Belgium. Leasure breath hold divers reported less BHD adverse events than competition divers and reported less SCUBA diving adverse events than SCUBA divers.

MVV increased significantly in more than half of these divers after only 4-8 training sessions.

MVV is a useful tool to follow coordination and/or endurance of respiratory muscles after a BHD training program for athletes. BHD training including MVV could therefore also be used as a revalidation program in different patient populations.

Keywords:
Breath hold diving, Training, Respiratory function, Maximal Voluntary Ventilation

O-09 INSPIRATORY LOADING DURING SCUBA EXERTION LEADS TO EXTRAVASCULAR LUNG WATER (EVLW) ACCUMULATION

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Introduction:
We observe that extravascular lung water (EVLW) accumulation is much larger when using Back Mounted Counterlung Rebreather (BMCR). With such rebreather, the negative Static Lung Load (SLL) imposes a negative pressure breathing (NPB) to the divers. We hypothesized that, NPB during dive would increase extravascular lung water (EVLW) accumulation.

Materiel and methods:
In order to confirm the major role of SLL on IPE occurrence, sixteen divers performed two 30 min shallow dives while breathing compressed air, one prone static (*PS*; SLL >0) and the second supine (SLL <0) finning (Negative pressure Exercise; *NE*) with a constant 110 beat/min heart rate. Before and immediately after immersion, cardiac function and EVLW accumulation were measured using cardiopulmonary ultrasound.

Results:
Average minute ventilation ($\dot{V}E$) was 4 times higher during *NE* than *PS* and the inspiratory work (WOB) during *NE* was 80 times that in *PS*. During *NE* the WOB cumulated over 30 min amounted to 130 times that of *PS*. Ultrasound lung comet tails (ULC) were found after *NE* but not after *PS*. Right atrial volume was increased by 80 % after *NE*. Right ventricle end diastolic and end-systolic volumes, the diameter of inferior vena cava and the systolic pulmonary arterial pressure were all increased after *NE*, but left ventricle volume and ejection fraction were unchanged in either condition. Plasma Nt-proANP concentration was 3-fold baseline after *PS* and 8 fold after *NE*. The numbers of ULC, the increases in right atrial volume and plasma Nt-proANP were all strongly correlated with the cumulated WOB.

Discussion:
During SCUBA, exercising with a negative SLL requires a high inspiratory work, able to substantially trigger extravascular lung water, and concomitant with a rise in right heart preload that seems poorly compensated for by a proportional increase in the left cardiac output.

Keywords:
Immersion pulmonary edema, Inspiratory breathing work, Negative pressure breathing

O-10 THE EFFECTS OF NORMOBARIC HYPEROXIA ON EXHALED NITRIC OXIDE, TETRAHYDROBIOPTERIN AND PHENYLALANINE

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Introduction:
Decompression sickness is believed to be caused by damage to the endothelium by gas bubbles formed during decompression. Nitric oxide (NO) has been indicated as a mitigating factor of adverse effects of gas bubbles. NO is a signal molecule involved in inflammatory processes and vasodilation, synthesized by the enzyme nitric oxide synthase (NOS). A key cofactor for this enzyme is tetrahydrobiopterin (BH4), which is also a cofactor for phenylalanine (Phe) hydroxylase that metabolises Phe to tyrosine. BH4 is prone to oxidation, and the oxidised products (BH2 and biopterin) cannot support NO-generation or conversion of Phe. Diving implies elevated pO_2 that may impair NO-generation thus increasing risk of decompression injury. In addition, impairment of Phe-metabolism may have neurological consequences. The aim was therefore to study the effect of hyperoxia on NO-production and plasma levels of BH4 and Phe.

Material and Methods:
Healthy subjects were exposed to 100% oxygen for 90 minutes. Exhaled NO (FE_{NO}) was measured before and one hour after exposure. Blood samples were analysed for biopterins and Phe. Each subject was their own control, breathing ambient air on a separate day.

Results:
Exposure to 100 % O_2 resulted in a non-significant decrease in FE_{NO} and Phe levels. No significant effects were observed for BH4 or BH2, while individual BH4/BH2 ratios increased for most of the subjects after hyperoxia.

Discussion:
Several studies have shown significant decrease of FE_{NO} after hyperoxia. However, the majority of these studies have determined the FE_{NO} 5-20 minutes after exposure, while the present results were obtained one hour after. This may suggest that a decrease in NO-generation is transient and returns to basal level within one hour. The decrease in Phe-level after hyperoxia was less than the similar response to air, suggesting that Phe-metabolism is less effective at hyperoxic conditions. Further studies are warranted to elucidate the time course after hyperoxic exposure and effects of possible antioxidant mechanisms.

Keywords:
Nitric oxide, Tetrahydrobiopterin (BH4), Hyperoxia

O-11 EXTRAVASCULAR LUNG WATER (EVLW) ACCUMULATION IS MORE IMPORTANT WHEN USING A BACK MOUNTED COUNTERLUNG REBREATHER COMPARED TO AN OPEN-CIRCUIT BREATHING APPARATUS

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Introduction:
It seems that Immersion Pulmonary Edema (IPE) is more frequent after during physical exertion using a Back Mounted Counterlung Rebreather (BMRC) compared to an open-circuit breathing apparatus (OCBA).

Material and Methods:
Fifteen healthy males performed a 30-min Scuba air dive in open sea (water temperature 14.6 ± 0.8 ° C). They were instructed to fin for 30 min (covering 900 m). In control condition (*Ctrl*.), divers used use OCBA, in experimental condition (*Exp*.), they used a BMCR. In both condition, divers used Nitox (40%N2, 60% O2) gas mixture. Before and immediately after immersion, cardiac function and EVLW accumulation were measured using cardiopulmonary ultrasound.

Results:
After the dive, mean ultrasound lung comet (ULC) score was significantly higher in *Exp*. compared to *Ctrl*. (respectively 17.67 ± 4.12 vs. 4.07 ± 3.41; p=0.0035). Right and left preload were increased in both conditions – as revealed by an augmentation in the diameter of the inferior vena cava (Δ IVC), in systolic pulmonary artery pressure (Δ sPAP), in left atrial volume and in left ventricle end-diastolic volume- but more importantly in *Exp*. condition. Left ventricle filling was also impaired in both condition-assessed by transmitral flow (EDT)-but more significantly during *Exp*. dive. In both condition, the right/left heart function imbalance was confirmed by the increase in right/left ventricle diameter ratio (RV/LV ratio) exceeding the normal value of 0.6. Furthermore, the ULC score correlated significantly with ΔIVC, ΔsPAP, ΔRV/LV ratio and ΔEDT values.

Discussion:
This study confirm that EVLW accumulation is more important when divers use BMCR. We objective that this higher EVLW accumulation is associated with a greater cardiac function modification induced by the dive. Because the main difference between BMCR and OCBA is the Static Lung Load value, we suspect that inspiratory work load (imposed by a higher SLL) could have an impact on ELVW accumulation and so increase IPE risk to arise.

Keywords:
Immersion pulmonary edema; Ultrasound Lung Comets (ULC), Extravascular lung water (EVLW), cardiopulmonary ultrasound, Back Mounted Counterlung Rebreather (BMCR)

O-12 INFLUENCE OF THE WET DIVING SUIT ON STANDARD SPIROMETRY

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Introduction:
A well-fitting wetsuit exerts a pressure on the body that may influence spirometry. This pressure is expected to reduce the forced vital capacity (FVC) due to a hampered inspiration. Because the spirogram is expected to be shape invariant for the pressure effects of the diving suit, FVC, the forced expiratory volume during the first second of expiration (FEV1), the peak expiratory flow (PEF) and the flow between 25 and 75% of FVC (FEF25-75) should change with the same fraction. This study investigates the influence of a wetsuit on spirometric variables using age, suit thickness and suit type as the parameters.

Materials and Methods:
Spirometry (dry) was performed in 28 volunteers (12 women), aged 27-69 years.

Results:
The wetsuit (3.8 mm, range 2-7 mm) resulted in a change in FVC of −4.0% ($P = 2{\cdot}E{-}08$), in FEV1 of −3.6% ($P = 3{\cdot}E{-}05$) and in PEF of −2.4% ($P = 0.03$); the FEF25-75 may also diminish. The FEV1/FVC ratio did not change. The decreases can be regarded as a quasi-ageing effect of about 3.5 years. No influence of age, suit thickness and suit type was found. Probably the study was underpowered to show the effects of these parameters.

Discussion: The wetsuit appears to impair ventilatory mechanics. Both the medical examiner and the diver should be aware that a too thick or too tight suit might be a potential pulmonary risk factor.

Keywords:
Lung mechanics, FVC, PEF, Suit thickness, Age

O-13 ACUTE HYPEROXIC EXPOSURE INDUCES A TH1 MEDIATED IMMUNE RESPONSE WITH SIMULTANEOUSLY INCREASED NUMBERS OF T_{REG}/B_{REG}

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Introduction:
Frequently exposures to hyperbaric oxygen showed immunosuppressive effects in animal studies, with reduced TH1 mediated immune response and elevated levels of anti-inflammatory cytokines such as IL10, produced by regulatory T and B cells. There is however little known about immunological effects in humans. The aim of this study was to assess changes in PBMC after one unique acute hyperoxic exposure.

Material and Methods:
17 healthy male non-divers (age 24.56±3.25) were exposed 30min to 280kPa oxygen. Peripheral blood mononuclear cells (PBMC) were collected one day before and directly after exposure and were examined for T- and B-cell compartments by flow cytometry measuring CD4, CD8, CD19, CD24, CD25 (IL2-Rα), CD38, CD39, CD45RO, CD69, CD127 (IL-7R), CD183 (CXCR3), CD196 (CCR6), CD197 (CCR7) and CD294 (CRTH2).

Results:
After 30min hyperoxic exposure, the PBMCs displayed elevated numbers of $CD4^+CD127^+$ T cells, central memory T cells (T_{CM}, $CD4^+CD197^+CD45RO^+$ T cells) and effector memory T cells (T_{EM}, $CD4^+CDCD197^-CD45RO^+$ T cells) which displayed a TH1 phenotype ($CD4^+CD196^-$ $CD183^+CD294^-$ T cells). While the numbers of $CD4^+CD25^{high}CD127^{low}$regulatory T cells ($T_{reg}$) did not change, the number of $CD39^+$ T_{reg} as well as the number of regulatory B cells (B_{reg}, CD19+CD24highCD38high B cells) increased.

Discussion:
The results indicate upregulated numbers of TH1 cells after one unique hyperoxic exposure as well as increased numbers of $CD39^+$ T_{reg} and B_{reg}.

Keywords:
Oxygen diving, Immune response, TH1 cells, Regulatory T cells (Treg), Regulatory B cells (Breg)

O-14 HYPERBARIC OXYGEN THERAPY PROMOTES WOUND CLOSURE AND PERFUSION IN ISCHEMIC AND HYPERGLYCEMIC CONDITIONS, INDEPENDENTLY OF MYOFIBROBLAST DIFFERENTIATION

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Introduction:
The treatment of chronic wounds remains inconsistent and empirical. Hyperbaric oxygen therapy (HBOT) is a promising method to improve wound repair but there is still a lack of understanding of its mechanisms of action and its indications are not yet clearly defined.

Material and Methods:
We studied the effects of HBOT in four different wound conditions by inflicting bilateral wounds on the dorsal aspect of the feet of non-ischemic or ischemic limbs in normoglycemic or hyperglycemic rats. To create an ischemic condition, arterial resection was performed unilaterally. Forty-four animals received HBOT five times a week until complete wound closure. Wound repair was compared to 44 rats receiving standard dressing only.

Results:
HBOT increased blood flow and accelerated wound closure in ischemic and hyperglycemic wounds, most significantly when the two conditions were combined. Wound contraction and re-epithelialization were equally stimulated by HBOT. However, the acceleration of wound contraction was not associated with increased myofibroblasts expression.

Discussion:
HBOT counteracts the negative effects of ischemia and hyperglycemia and accelerates wound contraction in a myofibroblast-independent manner. HBOT also strongly increases wound perfusion. When ischemia and hyperglycemia are combined, as it is often the case in diabetic patients, the effects of HBOT are most significant.

Keywords:
Hyperbaric oxygen therapy, Wound healing, Ischemic wounds, Diabetes, Myofibroblasts

O-15 COST IMPACT OF HYPERBARIC OXYGEN THERAPY FOR DIABETIC FOOT ULCERS

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Introduction:
Diabetic Foot Ulcers (DFUs) are a burden for health care system. HBOT is recommended in DFUs grade 3 and above on Wagner classification, not responding to adequate basic wound care after 30 days. The estimated average cost per DFU episode in Europe is 10,000 Euros (7,700 - 25,200 Euros). Considering the estimated population of DFUs in 2015, the indicative annual cost for DFU treatment is 210-290 billion Euros worldwide (21-29 million DFUs), 3,6 billion Euros in Europe (3.6 million DFUs), 1-1.4 billion Euros in EU-27 (1-1.4 million DFUs). HBOT may reduce the number of above-knee amputations (AKA) in DFUs.

Material and Methods:
Data published by the Health and Social Care Regional Agency of Emilia Romagna (Italy) were analysed to evaluate the AKA incidence from 2005 to 2014. USA data were used as benchmarks[1]

Results:
In 2010 the incidence of AKA in diabetics residing in Romagna *(Ravenna Hyperbaric Centre operational area)* was 0.18 /1000 diabetics compared to 0.75 AKA/1000 diabetics as average incidence for the Emilia Romagna region and 0.4 AKA/ 1000 diabetics in the USA. In 2014 were reported 0.18 AKA/1000 in the Romagna area and 0.67/1000 in the Emilia Romagna region (USA data not available).
The Number Needed to Treat (NNT) is 4 for less than 35 HBOT sessions. 35 HBOT sessions at 81 Euros each equals to 11,340 Euros as opposed to 10,800 Euros, the average cost of an amputation (DRG 113) excluding all indirect social costs. Applying the NNT of 4 to the estimated episodes of DFUs in EU-27 suggests that HBOT could save an indicative annual cost ranging from 283,500 to 396,900 Euros.

Discussions:
AKA rate in Romagna (where HBOT is used in the DFUs path) was 26.8% compared to the average in the Emilia Romagna region and 45% compared to the USA. The cost benefit ratio is favourable to the use of HBOT to reduce AKA in diabetics.

Keywords:
Hyperbaric oxygenation, Diabetic foot ulcer, Economics

[1]according to the Centres for Disease Control and Prevention of US Department of Health and Human Services (accessed by web on May 12, 2016)

O-16 FEMORAL HEAD OSTEONECROSIS AND HYPERBARIC OXYGEN THERAPY (HBO): A RETROSPECTIVE STUDY

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Background:
Femoral Head Necrosis (FHN) is a multifactorial disease that can result in a significant clinical morbidity and can affect patients of any age, including young and active people. It is essentially that final common pathway of a series of structural derangements, resulting in a sharp decrease in provisional blood flow to the femoral head (FH) leading to the cellular death, fractures, and collapse of the articular surface.

Materials and Methods:
249 patients, who presented to our care from 2004 until 2013, with FHN were enrolled into the study. They were treated with HBO (FiO_2=1.0) via face-mask at 2.5 ATA inside the multiplace Hyperbaric Chambers (Italy). Only 217 patients (age: 53.8 ± 11.7 yrs) could be analyzed after completing the follow-up. They received an average of 5 treatments per week, with an average of 70 total treatments. Principal level of severity: 30.2% Ficat I; 40.9 % Ficat II; 28.9% Ficat III and 9.6% bilateral. The end-points to the analysis were as follows: comparison of Visual Analogue Scale (VAS) values, comparison of MRI images and evaluation of femoral head survival before and after completion of HBO and at follow-up: 6 ± 3 yrs.

Results:
Comparison of VAS values indicated a significant change in pre/post treatment ($p< 0,016$); no changes in post/follow-up comparison. As per MRI analysis, we reported an improvement of 90.9%, 82.1%, 9.3% of Ficat I-II-III respectively. We registered a survival of joints by stage (follow-up: 6 ± 3 yrs) of 79.7% overall and respectively for stage I, II and III of 98.1%, 91.36% and 49.2%.

Conclusions:
HBO treatment is very effective on Ficat stage I and II, with literature support. The data presented also support HBO as the most successful therapy for FHN treatment in Ficat Stage I and II.

Keywords:
Femoral Head Necrosis, Hyperbaric Oxygen therapy, Ficat, VAS, MRI

O-17 HYPERBARIC OXYGEN CAN INDUCE ANGIOGENESIS AND RECOVER ERECTILE FUNCTION

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Introduction:
Erectile dysfunction (ED), the inability to achieve or maintain an erection sufficient for satisfactory sexual performance, is caused by micro- or macrovascular insufficiency in the majority of patients. Recent studies have shown that hyperbaric oxygen therapy (HBOT) can induce angiogenesis in different body organs. The effect of HBOT on the penis of patients suffering from non-surgery-related ED has not been investigated yet. The study objective was to evaluate the effects of HBOT on sexual function and penile vascular bed in non-surgical ED patients.

Methods and materials:
A prospective analysis of patients suffering from chronic ED. Clinical efficacy was assessed using the International Index of Erectile Function questionnaire (IIEF) and a global efficacy question (GEQ). The effect on the penile vascular bed was evaluated by perfusion MRI (dynamic contrast-enhanced magnetic resonance imaging). All patients were treated with 40 daily HBOT sessions.

Results:
Thirty men (mean age of 59.2±1.4) suffering from ED for 4.2±0.6 years completed the protocol. HBOT significantly improved all IIEF domains by 15-88% ($p<0.01$). Erectile function improved by 88% ($p<0.0001$) and 80% of the patients reported positive outcome according to the GEQ. Angiogenesis was indicated by perfusion MRI that showed a significant increase by 153.3±43.2% of K-trans values in the corpous cavernous ($p<0.0001$).

Conclusions:
HBOT can induce penile angiogenesis and improve erectile function in men suffering from ED. HBOT reverses the basic common pathophysiology, atherosclerosis and decreased penile perfusion, responsible for "age related" ED. Further studies are needed to evaluate the subgroups of men who can benefit the most from this treatment.

Keywords:
Erectile dysfunction, ED, Angiogenesis, MRI, HBOT

O-18 HYPERBARIC OXYGENATION THERAPY IN INFERTILITY PATIENTS – 17 YEARS OF EXPERIENCE

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Introduction:
To improve individually infertility factors and events we use hyperbaric-oxygenation therapy with different protocol more than 17 years.

Methods:
The patients were treated in multiplaced chamber at pressure of 2.1 ATA during 70 minutes, 7 - 10 days consecutively.

Results:
The evaluation of hyperbaric oxygen therapy was carried out and we notice improvement of spermatogenesis, endometrial oxygenation and vascularisation, with better eggs quality, better respond to ovarian stimulation, better embryo quality and higher pregnancy rate.
Desirable quality of endometrium was significantly better in the cycle when HBO therapy had been applied. The power doppler and 3DPD of the uterine arteries indicated that the uterine blood vessel resistance was higher, but that was expected reaction of the major blood vessels on hyperbaric therapy. Mapping of subendometrial blood vessels in the cycles covered and followed by hyperbaric oxygen therapy showed the intensive capillary network of endometrium especially 4-6 weeks after HBO therapy. In male patients significant increased in motor activity was registered as well as increased spermatogenesis two months after therapy.

Discussion:
The obtained results shows an extraordinary significance for better outcome of pregnancy implantation by improving endometrial receptivity. The acute exposure of the sperm samples to HBO has favorable impact to functional capacity of spermatozoids in view of their better motility. Prolongation and postpone effects of hyperbaric oxygen therapy were verified by semen analysis 70 to 90 days after therapy with the results of the good induction of the spermatogenesis, thanks to hyperbaric oxygen and elimination of the reactive oxygen species and avoiding infection due to hyperoxia. There are many factors that ultimately influence male and female fertility, and chances of conceiving, but our experience show that hyperbaric oxygen therapy could have positive impact on infertility treatment and increase male and female fertility.

Keywords:
Hyperbaric, Oxygenation, Infertility, Therapy

O-19 HYPERBARIC TREATMENT ATTENDANTS (HTA): IS IT USEFUL TO SCREEN THEM FOR PATENT FORAMEN OVALE (PFO)?

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Introduction:
Working as HTA is safe. Incidence of DCI (Decompression Illness) has been variously reported depending on treatment pressure (depth). The overall incidence rate was extremely low with no correlation of DCI and gender of tender. There was a linear correlation with increasing pressure and incidence of DCI.
We evaluate the opportunity, during the preliminary medical examination, to screen these workers for PFO.

Material and Methods:
We searched the avalaible literature in Pubmed and other sources like GTUEM literature database for case reports of DCI in HTA to consider it as an inherent risk and the role, if any, of PFO in these casualties.We find only case reports and analysis of the incidence of DCI in HTA.

Results:
We find that cases of DCI are very rare and almost absent where they adopt protective breathing oxygen decompression profiles involving HTA during the final phase of treatment according to the safety procedures

Discussion:
The risk of DCI is always present even if the subject is PFO free. The pressure exposures are in very low risk for both duration and depth. In Italy there are no case studies published. Are to our knowledge about 3 cases in 30 years in which the accident was due to a failure to oxygen breathing during the ascent, to multiple exposures on the same day, in one case the diagnosis of DCI was only supposed. Therefore, routine screening of HTA for a PFO is not warranted because the risk of DCI is low and the cost of screening is not justified. Furthermore, there are no clear guidelines.

Keywords:
Patent foramen ovale, Hyperbaric attendants, Decompression Illness

O-20 CALCULATION AND PRACTICE OPERATIONS OF HELIUM-OXYGEN DIVING DECOMPRESSION PROCEDURE AT HIGH ALTITUDE

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Objectives:
The purpose of this study was to calculate the high-altitude diving decompression table by using the air pressure ratio of high altitude and sea level, and to carry out high altitude helium-oxygen diving practice operations according to the calculated decompression table.

Methods:
Eight professional diver subjects who were divided into 4 groups participated in this experiment. The air pressure ratio of high-altitude and sea level was used as a correction factor to calculate the decompression table. We had carried out 45m/30min, 55m/30min, 65m/30min, and 75m/20min of helium-oxygen conventional diving above 3300m sea level in Tibet. Bubble sound in the precardiac region were monitored at 6m, 4m, 3m, 2m and 0m stops with Doppler ultrasound monitor among all 28 person-times diving decompression.

Results:
All diving data showed that there were no bubble sound in the precardiac region, and no decompression sickness(DCS) symptoms were found during all 45m/30min, 55m/30min, 65m/30min,and 75m/20min high altitude helium-oxygen diving practice operations.

Conclusion:
The helium-oxygen conventional diving decompression table calculated by correction factor seemed to be safe and reliable at 3300m high altitude.

Keywords:
High altitude; Helium-oxygen diving; Decompression table; Correction factor

O-21 POST-DIVE DETECTION OF BUBBLES IN SCUBA DIVERS EMPLOYING ELECTRICAL IMPEDANCE SPECTROSCOPY MEASUREMENTS

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Introduction:
Bubbles formation in the human body due to decompression may cause a clinical syndrome known as Decompression Sickness. Currently, only acoustic devices can detect the presence of bubbles but they are bulky, expensive, require trained personnel and are motion sensitive so they cannot be used as portable on-line bubble sensing devices in the field without significant compromises.

Methods:
Herein, bubbles in the human body are detected non-intrusively by I-VED (In-Vivo Embolic Detector) technology. I-VED is a patented electrical impedance spectroscopy technique of exceptional high spatial and temporal resolution (*European Patent Office, 3005942 A1*). A test campaign for bubbles detection in divers is performed in the NEMO 33 swimming pool in Brussels, Belgium. After ethical approval and informed consent, 17 volunteer divers are subjected to a well-defined dive profile at 33m depth for 20 minutes with water at 31ºC, while the evolution of bubbles formation in their body is studied for 2h post-dive. Electrical measurements are conducted applying self-adhesive ECG pads at the forearm site of divers and are validated against ultrasound measurements.

Results:
Acquired electrical signals are fragmented to three distinct frequency band components: LPF (0-0.5 Hz), BPF (0.5-10 Hz) and HPF (10-250 Hz). LPF and BPF components capture impedance variations in the scale of breathing and heart beat operations, respectively, while HPF component is considered chiefly as noise. Advanced statistical (time-series) analysis of the acquired signals demonstrates the effect of bubbles presence as a function of (post-dive) time. Furthermore, I-VED measurements seem to be in fair agreement with the ultrasound ones.

Discussion:
I-VED delivers promising results concerning early bubbles detection in humans. Further signal processing is currently carried out employing advanced algorithms (such as FFT/STFT, wavelets, spectrograms, HHT) in an effort to enhance bubbles detection, identify the detection limits and classify obtained results.

Keywords:
Decompression Sickness, Bubbles, Electrical impedance spectroscopy, Signal analysis

O-22 THE PERIPHERAL BLOOD TRANSCRIPTOME REFLECTS LEUKOCYTE SUBTYPE FRACTIONS AND ACTIVITY: APPLICATIONS IN DIVING

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Introduction:
A number of reports link diving to immune responses and systemic inflammation; the types and severity of which are likely to reflect the mode of diving as well as its pathophysiological outcome.
Blood is a complex tissue containing many different cell types, out of which leukocytes are essential constituents of the immune system. Leukocytes are also the only blood cells that have chromosome-containing nuclei; global gene expression in blood – the blood transcriptome - therefore ideally represents the biological state of its leukocytes.
While traditional transcriptome analysis addresses the activity of genes and biological pathways, several recent papers have introduced a novel approach that also takes cellular composition into account. This approach, adapted from signal processing in e.g. optics and astronomy, uses algorithms that deconvolute complex transcriptome signals to resolve contributions from distinct leukocyte subtypes present in the sample.

Material and Methods:
Through a series of studies, we have mapped peripheral blood transcriptomes before and after asymptomatic dives in experienced scuba divers, freediving athletes, and occupational saturation divers. We have performed transcriptome signal deconvolution for determination of leukocyte subtype fractions before and after dives, and used systems biology tools to assess the effects of diving on the activity of genes and biological pathways.

Results and Discussion:
The methodology as well as some results from our studies will be presented and discussed.

Keywords:
Gene expression, Immune system, Inflammation, Leukocyte subtypes, Systems biology

O-23 IS NITROX DANGEROUS FOR THE RECREATIONAL DIVER?

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Introduction:
While diving, the increasing depth increases the pN2 and pO2. To enjoy longer no decompression dives, or to shorten decompression times oxygen enriched air (=nitrox) is used which additionally increases pO2 and thus, the oxidative stress. By the way, nitrox reduces nitrogen narcosis.

Aim:
Investigate whether increasing O2 and reducing N2 exerts effects on pulmonary function, elastic properties of blood vessels, cognitive competence, and bubble formation.

Volunteers and Methods:
25 experienced divers (~40ys) performed one dive with air and another with Nitrox40 (max. 25m and 40min). Before and after the dive, pulmonary function (MasterScreen-IOS, CareFusion) and flow mediated dilatation (FMD; Periflux5000, Perimed) were assessed. Cognitive competence was assessed during the dive. Bubbles in the internal jugular vein (Doppler) were counted 30, 60, and 90 min after the end of the dive.

Results:
Diving with Nitrox40 lead to an increase of the peripheral pulmonary resistance by 19% (air: +9%), reduced the FMD by 29.5% (air: unchanged), improved memory and alertness, and reduced bubble formation by 15 and 50%, respectively.

Discussion:
Recreational divers use increasingly nitrox, in particular dive guides. The present results suggest that the increased oxidative stress impairs small pulmonary air ways as well as the vascular endothelium. On the other hand, cognitive competence is better preserved with less narcotic N2-effects. Moreover, less N2-bubbles are formed.

Conclusion:
Under the conditions of this study, Nitrox40 exerts both advantages and disadvantages. As disadvantages might accumulate over time, dive pauses should be allowed for injured organic tissue to recover.

O-24 MEASUREMENT OF THE DECOMPRESSION STRESS DURING OFFSHORE SATURATION

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Introduction:
Technip measured the decompression stress during actual North Sea saturation operations. Monitoring sessions were conducted on-board the Skandi Arctic DSV, during construction work at 120m (Alvheim field, Norway), according to NORSOK U100 instructions.

Material and Methods:
48 divers were monitored before pressurisation (12), after decompression (12) and before and after the saturation (24).
Subjects were experienced professional divers (mean age = 46.1 +/- 8.1, minimum 30, maximum 62 years old), mean BMI = 26.7 +/-2.3 kg/m2.
The decompression stress was assessed using two measurements:

- Venous gas emboli (Mindray M7 ultrasonic transthoracic echocardiograph with 2.5 Mhz probe for heart 4 chambers plane imaging and Doppler detection),
- Endothelial function measured in right brachial artery through flow-mediated dilation (FMD) (same echocardiograph with 7.5 Mhz linear probe).

Results:
No venous bubbles were detected in any diver immediately after or during the 12 hours following decompression, either by echography or Doppler monitoring.
Significant FMD variations were measured immediately after decompression with a slow return to pre–saturation values. An exponential regression with time (r=0.8124) of the relative FMD variation gave a 7% end decompression decrement and a half-time period of recovery around 3 hours (95% recovery in 12 hours).

Discussion:
The data confirm that NORSOK decompressions, being very slow, produce no detectable bubbles. This suggests that their current 24 hours bend watch period could be revised.
However, the oxidative stress associated to endothelial function variation remained significant, despite the moderate chamber oxygen levels (480-500 mbar to 13m, 22% to surface).
This suggests that bubble grade is mainly affected by the physics of gas exchange and bubble growth but that FMD is mainly associated to oxidative stress. These two measures define two independent dimensions of decompression stress. Their interaction suggests that a safe decompression is a trade off between oxygen levels and bubble grades.

Keywords:
Saturation diving, Decompression stress, Bubble detection, Oxidative stress

O-25 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 effects of saturation diving and 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 some specific biomarkers (PAI-1, IL-6, TNF-α and ICAM-1) 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.

Material and methods:
A total of 20 saturation diver on the DSV Skandi Arctic, all males in good physical health and 10 men working on the same vessel during the same period but working in non-diving functions were tested. They all submitted to FMD tests and blood samplings; pre and post-saturation for the divers and only once for the non-divers control group.
The FMD readings were analysed and artery diameters normalized with the blood flow velocity (nFMD) calculated. ELISA assays were conducted to quantify the blood stress biomarkers.

Results:
The results are still undergoing statistical analyses for interpretation.

Discussion:
The hypothesis is that we will possibly find a higher level of stress proteins and less significant dilation of the brachial artery in the divers than the non-divers. We also hypothesize that the divers who ingested additional antioxidants might have lower levels of blood stress proteins.

Keywords:
Saturation, Biomarkers, FMD

O-26 EXPANSION OF BUBBLES UNDER A PULSATILE FLOW REGIME IN DECOMPRESSED OVINE BLOOD VESSELS

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Introduction:
After decompression of ovine large blood vessels, bubbles nucleate and expand at active hydrophobic spots on their luminal aspect. These bubbles will be in the path of the blood flow within the vessel, which might replenish the supply of gas-supersaturated plasma in their vicinity and thus, in contrast with our previous estimations, enhance their growth.

Methods:
We used the data from our previous study on the effect of pulsatile flow in ovine blood vessels stretched on microscope slides and photographed after decompression from hyperbaric exposure. We measured the diameter of 46 bubbles in 4 samples taken from 3 blood vessels (pulmonary artery, pulmonary vein, and aorta) in which both a "multi-bubble active spot" (MBAS) - which produces several bubbles at a time, and at least one "single-bubble active spot" (SBAS) - which produces a single bubble at a time, were seen together.

Results:
The linear expansion rate for diameter in SBAS ranged from 0.077–0.498 mm/min and in MBAS from 0.001–0.332 mm/min. There was a trend toward a reduced expansion rate for bubbles in MBAS compared with SBAS. The expansion rate for bubbles in an MBAS when it was surrounded by others was very low. Bubble growth is related to gas tension, and under a flow regime, bubbles expand from a diameter of 0.1 to 1 mm in 2–24 min at a gas supersaturation of 620 kPa and lower.

Conclusions:
There are two phases of bubble development. The slow and disperse initiation of active spots (from nanobubbles to gas micronuclei) continues for more than 1 h, whereas the fast increase in size (2–24 min) is governed by simple diffusion. Bubble-based decompression models should not artificially reduce diffusion constants, but rather take both phases of bubble development into consideration.

Keywords:
Vascular bubbles, Hydrophobic spot, Growth rate, Blood flow

O-27 REPORT FROM THE 10TH ECHM CONSENSUS CONFERENCE ON HYPERBARIC MEDICINE (LILLE, FRANCE, 2016)

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The 10th European Consensus Conference on Hyperbaric Medicine took place in Lille, France, last April 14 and 15, 2016. The conference was participated by a large delegation of experts from all over Europe as well as non-European areas and focused on the revision of the current knowledge of hyperbaric Medicine with the scope to revise accepted indication according to the best available evidence based medicine modalities. For this scope the GRADE system for evidence analysis, together with the DELPHI system for consensus evaluation, were adopted. The previous indications for Hyperbaric Oxygen Therapy (dated 2004) were analyzed by selected experts, who made an extensive review of the literature and of the available EBM studies.

The Indications were divided in: Type 1, where HBOT is strongly indicated as a primary treatment method, as it is supported by sufficiently strong evidence; Type 2, where HBOT is suggested as it is supported by acceptable levels of evidence and Type 3, where HBOT can be considered as a possible / optional measure, but it is not yet supported by sufficiently strong evidence.

For each type, three levels of evidence were considered: A) when the amount of RCT studies is amply sufficient, B) when there are some RCT studies in clear favor of the indication and there is ample expert consensus, and C) when the conditions do not allow for proper RCT studies but there is ample and international expert consensus.

Finally, the conference also issued Negative Recommendations, for those conditions where there is evidence not to use HBOT and HBOT is considered as NOT indicated with a type 1 recommendation.

O-28 CARDIOGENIC SHOCK RELATED TO CARBON MONOXIDE POISONING

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Introduction:
We report here the observation of a patient who developed cardiogenic shock after CO poisoning (COp).

Case report:
A previously healthy 25-year-old woman, non-smoker, was taken in emergency for an acute onset non traumatic coma. In the ED, transthoracic echocardiography (TTE) revealed global hypokinesia with a severely depressed left ventricular ejection fraction at 10% and a cardiac index (CI) at 1.5 L/min/m . Initial arterial blood gas on high flow oxygen showed lactic acidosis: pH: 7.25; $PaCO_2$: 4.21 kPa; PaO_2: 90 kPa; HCO_3^-: 13.9 mmol/L; Lactate: 4.9 mmol/L and SpCO: 8.9%. In presence of neurologic manifestations, hyperbaric oxygen therapy (HBOT) for 90min at 2.5 ATA was started. No coronarography was performed.
After ICU admission, a Swan-Ganz catheter showed CI at 1.35 L/min/m^2, SvO_2 at 41%, CVP at 15 mmHg and PAOP at 25 mmHg. Considering the hemodynamic instability, no other HBOT session was performed. Hemodynamic optimization was obtained with catecholamine's infusions. Clinical course in ICU was rapidly favorable within 48 hours.

Discussion:
Our patient presented a severe cardiogenic shock secondary to COp. Despite an initially low COHb level, she required inotropic and vasoactive agents. Nevertheless, they were rapidly weaned.
CO cardio toxicity is caused by both tissue hypoxia and direct effects on the myocardium: CO binds to the myoglobin with a 60-times greater affinity than oxygen, thus reducing the oxygen supply to the mitochondria, impairing the oxidative phosphorylation and deteriorating the energy source of the myocardium. These abnormalities induce a hyper adrenergic state and a greater risk of developing arrhythmias. Furthermore, the compensatory tachyarrhythmia increases the oxygen demand and accelerates CO diffusion, which further exacerbates the hypoxic injury of the myocardium.

Conclusion:
Even if the initial CO blood level measured is low, COp can be associated with severe cardiac dysfunction, leading to profound cardiogenic shock. Therefore, it appears essential for emergency physicians to identify features of myocardial injury in case of COp by performing electrocardiogram, cardiac markers and TTE. Cardiac dysfunction is sometimes severe but often short. In case of failure of maximal medical therapy, a short-term cardiac assistance should be considered. If hemodynamic condition permits, these patients should have access to a faster HBOT, so as to limit cardiac and more importantly neurological sequelae.

O-29 PROGNOSIS AT 6 AND 12 MONTHS AFTER SELF-ATTEMPTED HANGING TREATED BY HYPERBARIC TREATMENT

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Introduction:
Patients surviving a self-attempted hanging present a anoxic encephalopathy which is recognized as an optional indication for hyperbaric oxygen (HBOT). Previous studies have shown a total neurological recovery in 57–77 % of patients. If mortality risk factors of post-hanging patients have been identified, long term morbidity prognostic factors have not. A follow-up study with neurological evaluation at 6 and 12 months have been undertaken to determinate those factors.

Material and Methods:
In this observational study, all patients hospitalized for post-hanging in ICU in a 5 year period were included. Prehospital and ICU data were collected. Neurological evaluation at 6 and 12 months was performed according to CPC scores.

Results:
231 patients with median age of 40.3 years [IQR 30-50.2] were included. 104 patients (47%) were found in cardiac arrest (CA). HBOT was performed in 95% of patients. Mean delay between resuscitation and first HBOT session time was 120 minutes [IQR 90-180]. 95 patients died in ICU (41%), 93 (89%) in CA group and 2 (1.6%) in the group without CA. Neurological evaluation at 6 and 12 months was obtained in 99 of the 136 patients alive. At 6 months, in the CA group (n = 9), CPC score was respectively 1 for 6 patient, 2 for 2, 4 for 1. At 12 months, CPC score changed only for the 2 patients with a CPC score at 2 (one died after another suicide attempt, one changed his CPC score to 3). In the group without CA (n = 92), 83 had normal neurological status at 6 months and 82 at 12 months (one patient died because of a cancer). Within these patients, 96% returned at home and 77% returned to work. 16 (16%) patients re-attempted suicide in the year. In univariate analysis, risk factors of neurological sequelae at 6 months, was SAPS II (p=0.04), elevated diastolic blood pressure (p=0.04), initial Glasgow score (p=0.05), elevated blood glucose (p=0.008). In multivariate analysis, only cardiac arrest is predictive of a CPC score > 1 (OR 0.001 [0.038 to 0.937]).

Discussion:
Patients surviving a self-attempted hanging who have not presented CA and treated by HBOT have a good neurological outcome. Randomized control study should be undertaken to confirm HBOT effectiveness in that indication.

Keywords:
Hanging, Hyperbaric oxygen treatment, Outcome

O-30 GAS EMBOLISM AFTER CARDIOVASCULAR SURGERY: IS IT IMPORTANT TO OBTAIN DIAGNOSIS CONFIRMATION BEFORE HYPERBARIC TREATMENT?

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Introduction :
Gas embolism (GE) is a potential complication of cardiovascular surgery, often lifethreatening. Rapid recognition is mandatory to initiate emergency treatment by HBOT but confirmation of diagnostic may be difficult to obtain without delaying the hyperbaric session. So, GE suspicion on clinical history and manifestations is often thought to be sufficient to start the hyperbaric treatment. The aim of our study was to assess if there is any difference in clinical manifestations, management and outcome according to proven or only suspected GE diagnostic.

Material and Methods :
All records of patients hospitalized in our hyperbaric center for gas embolism after cardiovascular surgery between 2005 and 2008 were reviewed. Pre, intra and post-operative data, clinical manifestations at hyperbaric center admission, treatment and outcome were collected. Difference between the group of patients with a proven GE and the group of patients with only suspected GE was searched by t-test or Chi-square according to quantitative or qualitative data. A p value of less than 0.05 was considered as statistically significant.

Results:
31 patients were included in the study. Global incidence of gas embolism in cardiac surgery was 0.3%. Most frequent initial signs were seizure (72%) and delay in post-operative consciousness recovery (22%). Median time between surgery and HBOT was 542 minutes [475-762]. Persistent sequelae were present after complete treatment in 39% of cases. No difference was found according to proven or suspected GE for any clinical, biological parameters or outcome.

Conclusion:
Clinical presentation is the same whether diagnosis of GE is proven or only suspected. A suspicion of gas embolism is sufficient to stat emergency treatment. Awaking early patients after cardiovascular surgery is essential.

Keywords:
Gas embolism, Hyperbaric oxygen treatment

O-31 DELAYED HYPERBARIC OXYGEN THERAPY FOR AIR EMBOLI AFTER OPEN HEART SURGERY: REPORT AND REVIEW OF A SUCCESS STORY.

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Background:
The current case describes a rare diagnosis of iatrogenic air emboli post elective cardiopulmonary bypass that was successfully treated with delayed hyperbaric oxygen therapy, with good clinical evolution in spite of rare complications.

Case Presentation:
35 years old male admitted in the intensive care unit (ICU) for post-operative management after elective cardiopulmonary bypass (CPB) for ventricular septal defect closure and aortic valvuloplasty. The patient initially presented pathologically late awakening and was extubated 17hours after admission. Neurologic clinical status after extubation showed global aphasia, mental slowliness and spatio-temporal disorientation. The injected cerebral CT scan was normal, the EEG was non-conclusive (showed metabolic encephalopathy with no epileptic activity), the cerebral MRI done 48 hours after surgery showed multiple small subcortical acute ischemic lesions mainly on the left fronto- parieto- temporo-occipital lobes. He was taken for hyperbaric oxygen therapy (HOT) over 54 hours post cardiac surgery. The first session was interrupted abruptly after 20 minutes when the patient presented generalised tonico-clonic seizures, necessitating a moderately rapid decompression, airway management, and antiepileptic treatment. The patient received in total 7 HOT sessions over 6 Days and presented full neurological recovery at 4 weeks and GOS (Glasgow Outcome Scale) of 5, even after a long delay in initial management. Convulsions are a rare complication of HOT either due to reperfusion syndrome or hyperoxic toxicity and can be managed. Prior imaging by MRI or tympanic paracentesis (myringotomy) should not add further delay of treatment.

Conclusion:
HOT should always be initiated upon suspicion of late awakening after CPB heart surgery after exclusion of formal counter-indications even after more than 48hours delay.

Keywords:
Iatrogenic cerebral air emboli, Neurologic deficit, Cardiopulmonary bypass (CBP), Cardiac surgery, Hyperbaric oxygen therapy (HOT)

O-32 A RETROSPECTIVE STUDY OF THE TREATMENT OF BURNED PATIENTS IN THE HYPERBARIC UNIT

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Introduction:
Hyperbaric oxygen therapy (HBO) as an adjunct in the treatment of burn injuries improves healing times and reduces infection.
The aim of this study was to do a review of burned patients referred to the Hyperbaric Unit (HU) by plastic surgery department and to analyse if there were changes after the institution of a local protocol of burn care.

Methods:
This is a retrospective study with data collected from the informatics process (Glintt® and PICIS®) between 2010 and 2015. Patients were chosen according to the modified American Burn Association (ABA) referral criteria. HBO at 2.4ATA with 90' O_2 in 3 periods of 30'. Data collected: age, sex, ASA, Total Body Surface Area (TBSA), type of burns, number of surgeries before HBO and number of sessions of HBO. We excluded the patients with burn sequelae.

Results:
Of the 34 patients treated in the HU, 31 were included, 18 men and 13 females, mean age 40±17. Type of burns: 25 thermal burns and 6 chemical burns, with a mean TBSA of 11.8%. The mean number of sessions of HBO was 21.7 [4-50]. The patients were divided in 2 groups: A (after protocol) and B (before protocol). Of the 23 patients of group A, only one (4.3%) went more than twice to the operating room (OR) before initiation of HBO while seven (87.5%) out of eight patients of group B went more than twice to the OR before initiation HBO ($p<0.001$). There was a difference in the mean of the number of sessions of HBO in group A (18.1 [4-30]) and in group B (31.9 [19-50]) ($p<0.001$).

Discussion:
After the introduction of the local protocol, the burned patients went less times to the OR before initiating HBO as they were referred earlier to the HU and needed less sessions of HBO.

Keywords:
Burns, Hyperbaric Oxygen Therapy, Plastic surgery

O-33 DOCUMENTATION AND MONITORING OF PATIENT INFORMATION IN EUROPEAN HYPERBARIC FACILITIES

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Introduction:
Hyperbaric oxygen (HBO) therapy is a treatment given all over Europe, but with differences in treated indications, session profile and number, and monitoring of success. We were curious to see how the documentation of patient information is organized throughout hyperbaric facilities in Europe.

Materials and methods:
An anonymous, electronic questionnaire was uploaded to the EBAss website. Using the list of European hyperbaric facilities as provided by Oxynet.org an e-mail was send to all facilities with a link to the questionnaire. After 3 weeks and a reminder-mailing the results were analyzed.

Results:
Out of the 184 successfully sent emails, 33 facilities (18%) responded. 45% of the facilities treated more than 250 patients per year, and almost all facilities were multiplace only (82%). 13 facilities used an electronic patient record, others had paper charts. 55% regularly use VAS-scores to monitor pain, 24% use items of the LENT-SOMA to score late radiation tissue injury. All facilities perform wound inspection, measurement and photo's when treating a diabetic ulcer, 68% add transcutaneous oximetry. 76% use laboratory results to monitor patients' illness. 36% use quality of life questionnaires, mostly SF-36 and EQ-5D. 67% follows up on patients by scheduling an appointment, 21% does not follow-up at all. 22 out of 33 facilities have performed retrospective analyses on their documentation, for example on complications, number of sessions and annual success rate.

Conclusions:
The response rate was low, giving high risk for bias. There were large differences between responding facilities, ranging from facilities that schedule regular check-ups and that use validated tools (VAS, quality of life questionnaires, LENT-SOMA) to measure complaints, to facilities doing none of this.
It would be advisable if a consensus document could be designed as to what patient information should be recorded as a minimum, to facilitate European collaboration in multicenter analysis and publication of European treatment results.

Keywords:
Hyperbaric oxygen therapy; Electronic patient record; Treatment monitoring; Treatment success

O-34 DECOMPRESSION LIKE SICKNESS IN RISSO'S DOLPHINS: DEADLY HUNTING

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Introduction:
Pathologies related to effects of changes in pressure are well known among human divers. Breath-hold diving vertebrates, including marine mammals and sea turtles, have long been considered protected against decompression sickness (DCS) through anatomical, physiological, and behavioral adaptations. However, an acute and systemic gas and fat embolic syndrome similar to DCS in human divers was described in beaked whales that stranded in temporal and spatial association with military exercises involving high-powered sonar. Gas embolism has been also described in gillnet-drowned bycaught marine mammals and turtles. In both cases, "gas embolism" has been linked to anthropogenic causes. Here we present an acute systemic "gas bubble" pathology, resembling lesions of DC Sickness, in two Risso´s dolphins (*Grampus griseus*). Risso's dolphins inhabit deep oceanic and continental slope waters (400-1,000m deep). They are thought to feed on vertically migrant and mesopelagic cephalopods as the neon flying squid (*Ommastrephes bartramii*).

Material and Methods:
Necropsies of Risso's dolphins stranded on the Canary coast were carried out by Veterinary Pathologists and followed a standardized necropsy protocol, which includes gas scoring, and gas analyses.

Results:
Main pathological findings were: good body condition, external skin marks caused by squid interaction, fresh undigested large squid (*Ommastrephes bartramii*) in fore stomach and esophagus, large amount of intravascular gas bubbles disseminated in the venous system, and emphysematous coronary fat depots. The amount of gas found in these animals was much larger than the amount of gas observed in other stranded Risso's dolphins. Gas analyses results were consistent with decompression gases.

Discussion:
We conclude that squid-dolphin interaction during feeding was the primary cause of Risso´s dolphin diving fatality though a pathogenic mechanism which was triggered by an acute severe stressful decompression very similar to that reported in stranded beaked whales linked to anthropogenic sound during naval military exercises.

Keywords:
Breath-hold diving, Decompression sickness, Marine mammals, Risso's dolphin, Prey interaction.

O-35 EVALUATION OF THE DIVER AFTER SERIOUS CARDIOPULMONARY DIVING ACCIDENT

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Introduction:
Cardiopulmonary DCS or scuba divers´pulmonary edema (SDPE) are fortunately rare incidents but potentially fatal. Here we describe two patients and how they were evaluated for their diving fitness after major accident.

Case 1: 33 y/o male, experience 250 dives, trimix-CCR. Dive information: max. depth 35 m, bottom time 50 min, total dive time 80 min, water 4°C. Leak in dry suit and becomes progressively cold during dive. Ten minutes after surfacing severe coughing and cutis marmorata, FAO_2 started, evacuated. During transportation resuscitated twice from cardiac arrest, recompression in ICU. Survives with final diagnosis cardiopulmonary DCS.
Case 2: 43 y/o female, experience 600 dives, trimix-CCR. Dive information: max. depth 38 m. At 9 min she starts vigorously coughing, shortness of breath, returns at 19 min and reaches surface at 26 min. At surface unconscious and is rescued. Intubation was difficult due to severe pulmonary edema (PE) in respiratory tract. Evacuated and recompressed in ICU. Survives with final diagnosis SDPE with mild DCS (joint pain and mild sensory changes).

Evaluation of diving fitness:
Both divers are motivated resume diving. Hence, potential contributing risk factors were discussed and performed FTD. In addition, divers underwent body impedance, echocardiography, a large repertoire of lung function and cardiopulmonary maximal exercise (spiroergometry) tests. Both divers had normal exercise performance and maximal oxygen uptake ($V0_2max$). However, diver 1 showed a tendency to insufficient breathing and $C0_2$ retention during exercise. This raises safety concerns as $C0_2$ retention is a well-known risk factor for dive accidents. In order to understand better underlying risk factors, we investigated also three different genetic variants frequently associated with PE in divers (eNoS G894T, eNoS T786C and ACE insertion/ deletion). Both divers showed no genetic predisposition to PE, indicating that these two events implied significant environmental and physiological stress, able to affect even PE "resistant" phenotype variants, such as with diver of the case 1.

Conclusions:
Severe cardiopulmonary diving accident may cause permanent lung injury. Spiroergometry can provide vital information about predisposing factors and modern gene tests may bring some additional information for risk assessment.

Keywords:
Pulmonary edema, Cardiopulmonary DCS, Fit-to-dive, Spiroergometry, Gene testing

O-36 CORPSE OF RECREATIONAL DIVER FOUND IN THE HOTEL ROOM: SICKLE CELL ANAEMIA – A CASE REPORT

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Personal data:
The deceased (EK: 24ys), male, well trained, was in good general health, albeit having drepanocytosis. Although diving is not advised, EK had completed a dive course.

Chronology:
In 2013, EK travelled to Indonesia and performed 48 dives during 5 weeks. EK undertook his last dive in the afternoon of 30.June. Next day, he was sitting late afternoon on his hotel balcony. His corpse was found next noon (2.July) in his hotel. Because use of force was excluded, the corpse was released and repatriated.

Diving history:
Dive computer showed rather moderate dives (10 to 30m; 50 to 60min), disclosed no violation of dive rules. EK undertook repetitive dives (2 to 3/day), but reduced this practice to 1 dive/day shortly before his death.

Autopsy / Forensic Medicine:
As cause of death, the Indonesian physicians gave drowning during a dive. After autopsy (Pathology, Essen, DE) a dilated left lung (extensively superimposing the pericardium), an entirely collapsed right lung but no characteristic signs of drepanocytosis were reported, ruling out the severe, homozygote form.

Analysis:
It would become a case of corpse dumping, if EK would have drowned in the water. More reasonable seems (unnoticed?) pulmonary barotrauma during the more recent dives. A parietal pulmonary rupture – resulting from trapped air – would have caused pneumothorax. Even with a very small rupture, a tension pneumothorax might have developed over some days. Owing to his excellent physical condition, EK could survive for a couple of days. Eventually, the left lung entirely collapsed and death occurred after cardiac and circulatory failure.

Conclusion:
The death was not related to drepanocytosis. Pulmonary barotrauma resulted although dives were within the rules for safe diving. Divers should bear in mind that discomfort – even if mild – might be dive-related and contact a diving physician. If no one is on-site, hotlines are recommended.

Keywords:
SCUBA diving, Case report, Barotrauma, Drepanocytosis

O-37 DETERMINATION OF INTRACADAVERIC GASES COMPOSITION IN DIVING FATALITIES FOR FORENSIC INVESTIGATIONS

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Introduction:
The determination of the cause and circumstances of death during diving is never easy. Postmortem gas occurrence could derive from barotrauma, decompression sickness, resuscitation procedure, postmortem off-gasing and decomposition. Today, the forensic imaging tools such as Multidimensional Computed Tomography (MDCT-Scanner) and Magnetic Resonance Imaging (MRI) allow to orientate the diagnosis with the gas bubbles distribution according to the diving profile and postmortem delay. These techniques are very informative and allow a preliminary diagnosis without body dissection. However, these approaches should be validated by the composition of the gas bubbles to avoid misinterpretations, especially caused by decomposition.

Materials and Methods:
Six cases of scuba diving fatalities occurred in Swiss lakes during the last 5 years were studied. Bodies were CT Scanned, examined and five were autopsied. Intracadaveric gases were sampled following gas sampling protocol under laser guidance and analysed by gas-chromatography coupled to thermal conductivity detection (GC-TCD). The different gaseous compositions were compared with specific emphasis on cardiac carbon dioxide (CO2) and related to the diving profiles, postmortem delays, resuscitation procedures and finally confronted to autopsy results and medicolegal conclusions.

Results:
Intracadaveric gases compositions were very useful to identify decomposition gases (hydrogen H2, hydrogen sulfide H2S and methane CH4) and to avoid a false interpretation by forensic radiologist, because these gases can be generated rapidly after death. The intracardiac gaseous CO2 concentration was found really informative when interpreted simultaneously with the diving profile. This concentration is clearly positively linked to the depth in case of postmortem off-gasing after drowning underwater and in case of barotrauma with body recovery at surface.

Discussion / Conclusion:
Intracadaveric gases sampling and analysis has become a useful step accompanying the forensic radiological diagnosis. It is also helpful to complete the medicolegal conclusion about circumstances and cause of death.

Keywords:
Intracadaveric gases, Diving fatality, Postmortem imaging

O-38 PSYCHO-COGNITIVE FUNCTION OF CHILDREN IN OPEN WATER SCUBA DIVING

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Introduction – Background:
Few psychological fitness data are available regarding scuba diving of children. This pilot study will investigate psycho-cognitive functions of children in open water diving (OWD) using different psycho-cognitive tests, and compare the differences between swimming pool diving and OWD effects on psycho-cognitive functions.

Materials and Methods:
31 children, age 8-15 years old, with no incompatible medical conditions for OWD evaluated by a physician, were allocated to groups with (n=20) and without or little experience (n=11) in OWD (≤ 15 dives).
Biometric data and Zung Self-Rating Anxiety Scale (Zung-SAS) were collected at start. Psycho-cognitive tests (PEBL Math Processing Task [1], Perceptual Vigilance Task [1], Time Wall [2] and Critical Flicker Fusion Frequency[1]) and Urine Specific Gravity Test [2] were measured before (1,2), during (1) and after (1,2) a standardized OWD. The underwater measurements of Math Processing Task (PEBL) and Perceptual Vigilance Task (PEBL) were made possible by implementation of these tests in an ICON dive computer by Mares.

Results:
Zung-SAS was within normal range in all children (except one with a mild anxiety level). Urine specific gravity wasn't significantly decreased in both groups. Results of PEBL tests weren't significantly different before, during and after training in both groups, but we can observe a slight improvement of the results of all tests during underwater training. The outcomes of Critical Flicker Fusion Frequency during the dive is highly significantly better in the experienced group ($p < 0.05$) and also significantly better in the non-experienced group ($p < 0.05$) compare to results before and after the dive.

Conclusions:
OWD did not influence these psychometric tests negatively. The brain functions observed were not disturbed by diving. Perceptual Vigilance Task and Critical Flicker Fusion Frequency are easy-to-implement, user-friendly and give most useful information regarding the psychological fitness and safety of children for OWD.

Keywords:
Children, Open water diving, Psychological fitness, Psycho-cognitive tests

O-39 PROCESS TO CONSIDER FITNESS TO DIVE IN A WORKING DIVER WITH INSULIN-DEPENDENT DIABETES - A REFERENCE CASE DESCRIPTION.

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Introduction / Background:
The EDTC book on medical assessment of working divers 2004 (Wendling et al) states: "Once diabetes is diagnosed in a working diver, an automatic disqualification may seem wise, but is no longer acceptable".
Question: is a working diver (a scientific diver) that got insulin-dependent diabetes after working diver certification fit to dive according to Swedish legislation (Ordinance 2005:6). If yes, what requirement on limitation of work tasks has to be reported to the employer (work ability)? What special requirement for the fitness to dive (FTD) examination has to be put on the physician (medical examiner of diver –EDTC)?

Materials and methods:
We arranged hearing of several scientific qualified experts in Sweden in diving medicine, in diabetology and diving in addition to a physician at The Swedish Work Environment Authority. We had a several mailings with suggested statements backed up by scientific literature.

Results:
We did not reach consensus but a majority of experts consented to the following statements. Restrictions on work tasks and diving procedure was sent to the employer. Furthermore, also requirements of the FTD examination.

Conclusions:
1. Must dive together with other working diver. May be employed only in physical light underwater work: guidance, observation, photographic documentation, collection of bottom samples. A written risk assessment dive plan has to be present when working.
2. NN (the scientific diver) has insulin dependent diabetes mellitus, diving and underwater work should be done according to published guidelines for diabetic divers and the dive team should be informed of the condition.
3. Requirements for FTD: Annually assessed by a diving medicine physician. The diabetes doctor treating NN should provide information. HbA1c in the range 45-55 mmol / mol. Last HbA1c 3 month. Never had diabetes or insulin coma. Not had diabetic ketoacidosis (DKA) the last 2 years. Have adherence in diabetes with regular visits, 4 blood tests per day or CGM (continuous glucose monitors), and presence of adrenergic symptoms at low blood sugar. No complications of diabetes (eyes, kidneys, feet, nerves). Have good knowledge of diabetes and handling of hypoglycemia.

Other types of working divers would probably not be able to meet these work requirements and be disqualified as working divers.

Keywords:
EDTC, FTD, Diabetes

O-40 EVALUATION OF STRESS DURING THE TRAINING FOR FIRE FIGHTER DIVERS: AIR CONSUMPTION, HEART RATE AND PSYCHOMENTAL CHALLENGES.

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Introduction:
Fire departments train divers for search, rescue and recovery in and under water. Their tasks are associated with series of extraordinary stress. Beside diving-induced stress of heart, circulatory system and respiration, psychological stress needs mentioning, e.g. during emergency missions. Aim: Does measuring heart rate and air consumption permit assessment of stress during the different training dives, and is the training concept of the fire department adequately designed.

Methods:
Seven fire fighters participated in the training and performed together about 300 dives in different waters. Air consumption (V_{air}) was assessed using pressure gauges, and heart rate was assessed using diving computers plus chest belts (Uwatec/Polaris). The candidates evaluated the subjective stress of each dive using a questionnaire.

Results:
V_{air} averaged 46±20 l/min (mean±SD). Heart rate (HR) immediately after dive begin was with 119±19 /min high for young, well-trained males. HR decreased during the dive to 111±26 /min. In the course of the training, V_{air} and HR remained unchanged. V_{air} and HR correlated significantly (r=0.40). Altogether, psychomental challenges during the training were constantly described as being low. Training dives that were evaluated as being less successful were characterized by elevated HR and V_{air}.

Discussion/Conclusion:
V_{air} and HR were clearly elevated compared with standard values. This finding in this group of young well-trained males is likely owing to both demanding physical and psychomental stress. Because the relatively high values remained unchanged during the training, it is suggested that the level of the task and the increase in the level of competence nicely matched. The only moderate variations in the evaluation of the psychomental stress is plausible for a highly selected group that was successfully trained to adequately cope with stress situations. Thus, the training concept seems successful in view of the selection of the candidates and the learning spiral slope.

Keywords:
Professional Diving; Training Success; Fire Fighter; Air Consumption; Heart Rate

O-41 BLOOD-BRAIN BARRIER DISRUPTION FOLLOWING CNS OXYGEN TOXICITY

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Background:
The blood-brain barrier (BBB) facilitates the passage of molecules to brain tissues. Data collected in recent years suggest significant involvement of the BBB in events characterised by seizures, such as epilepsy. The cause and effect relationship between disruption of the BBB and the occurrence of seizures is as yet unknown. In the present study, we examined changes in BBB integrity following exposure to hyperbaric oxygen (HBO) at different pressures.

Methods:
The extent of vascular leakage was measured by fluorescent Evans blue (EB). This dye binds to serum albumin, which does not cross the BBB under normal physiologic conditions. Male Sprague-Dawley rats were divided randomly into four groups: 1) Sham; 2) Control – rats not exposed to HBO; 3) 3 ATA – animals exposed to non-convulsive HBO at 3 atmospheres absolute (ATA) for 45 minutes; and 4) 6 ATA – animals exposed to HBO at 6 ATA until the appearance of convulsions. EB was injected into the tail vein of rats from groups 2-4 eight hours prior to HBO exposure or tissue harvesting. On completion of the exposure to HBO, rats were sacrificed. Brain samples were processed for light and fluorescent microscopy analysis. Linear slopes were calculated for EB diffusion from blood vessels into brain tissue, and for the distance to 50% of original fluorescence.

Results and discussion:
The preliminary results, seen in Table 1, suggest disruption of BBB integrity on exposure to HBO at 6 ATA culminating in seizures. It is possible that there is a gradual rise in BBB permeability which correlates with the pressure of the HBO exposure. We therefore suggest that it is disruption of the BBB which facilitates the occurrence of seizures, and not seizures which cause disruption of the BBB.

Table 1:

	Control	**3 ATA**	**6 ATA**
Distance to 50% [µm]	10.6±2	8.3±1	38.0±10
Linear slope	1138.1±382	715.4±114	240.4±99

O-42 IMMERSION INDUCED FLUID REDISTRIBUTION OF MORE THAN 3 % OF TOTAL BODY WEIGHT - PROSPECTIVE, RANDOMIZED, CROSSOVER CLINICAL TRIAL IN ANURIC HEMODIALYSIS PATIENTS

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Background:
Water immersion induces transfer of volume from the interstitial to the intravascular space. Elevated intravascular volume induce water and salt diuresis. In anuric patients treated by hemodialysis (HD) fluid removal can only be done by ultrafiltration (UF) thus this population can serve as an excellent human model for evaluation of fluid redistribution during immersion. The aim of the present randomized, crossover study was to evaluate the physiological and clinical effects of immersion on water redistribution in anuric patients undergoing fix dose ultrafiltration during dialysis.

Methods:
Ten male HD patients were randomized to two dialysis sessions, "wet" and "dry", in a crossover manner. The wet session was performed while immersed up to the neck in a 34-35ºC bath, and the "dry" was standard HD session. UF goal was determined as the mean UF during the 10 preceding the study sessions, and the dialysis time was shortened to 3 hours instead of the usual 4 hours. Symptoms, blood pressure(BP), blood ANP and aldosterone were measured through the sessions.

Results:
Mean fluid removal was similar during the two sessions (2.99±0.64L vs. 2.96±0.74L in wet and in dry sessions respectively) equivalent to 3.25% of patients' weight. Systolic BP adjusted for UF was stable during the wet session, +0.22mmHg (95% CI -0.27 to 0.7) but significantly decreased during the dry session -0.68 mmHg (95%CI -1.24 to-0.11), P=0.02. Symptomatic hypotension developed in 40% of the patients during the dry session and did not developed during the wet session. ANP significantly increase in the wet session 31.36pg/ml (95%CI 8.73 to 53.99) P=0.07, and slightly and insignificantly decreased in the dry session -21.66 (95% CI -52.59 to 9.25) P=0.167. Aldosterone did not change through the sessions.

Conclusion:
Water immersion induce significant fluid redistribution from the extracellular to the intravascular compartment, increases ANP and can compensate for fast removal of volume equivalent to 3.25% of body weight.

Keywords:
Immersion, Hemodialysis, Redistribution

O-43 SUCCESSFUL TREATMENT OF PNEUMATOSIS CYSTOIDES INTESTINALIS BY HYPERBARIC OXYGEN THERAPY (HBOT) : A CASE REPORT

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Introduction:
Pneumatoses intestinalis (PI), or submucosal or subserosal gas cysts in the wall of the small or large bowel, traditionally indicate intestinal ischemia in the acute setting. However, it can also be an incidental finding which is increasingly detected due to the frequent use of abdominal computed tomography (CT). Pathologically there is loss of bowel wall integrity which can be caused by diverse etiologies. As a result, gas can migrate through the bowel wall and then spread longitudinally along the wall of the digestive tract, possibly through the mesenteric veins, and sometimes extends until the intrahepatic portal branches. While in a benign form, patients may be asymptomatic or only present with chronic abdominal pain. Acute forms due to mesenteric ischemia are life-threatening related to bowel necrosis, and requiring immediate surgery. In benign and chronic forms, treatments include antibiotic therapy, diet, and oxygen therapy. Up until now, only a few cases have been reported on the use of hyperbaric oxygen therapy for PI.

Case presentation:
A 66-year-old female patient with disseminated PI of the colon was referred for hyperbaric oxygen therapy because of chronic refractory symptoms including bloating, abdominal cramps, mucous discharge, and chronic constipation. She had previously been unsuccessfully treated with several antibiotics, mask oxygen therapy and low-fiber diet. She was exposed to HBOT with a Heliox session at 4ATA during 170mn the 2 first days then 2 standard sessions (2,5ATA, 95mn) per day the next 9 days. After the first round of treatment, she felt completely relieved as demonstrated by a complete disappearance of abdominal pain, bloating and a more regular transit. Additionally, serial virtual colonoscopies by CT that had been performed before and after treatment demonstrated a significant decrease in the extension and size of the gas bubbles situated in the colonic wall.

Conclusions:
We present a case of symptomatic PI successfully treated by hyperbaric oxygen therapy after failure of conventional therapies illustrating improvement at serial virtual colonoscopies. Although not readily available, this treatment should be considered in refractory patients.

Keywords:
Pneumatosis intestinalis, Subserosal gas cysts, HBOT

O-44 HYPERBARIC OXYGEN THERAPY IN PEDIATRIC AGE

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Introduction:
Hyperbaric oxygen therapy (HBOT) is a therapeutic method recommended for the treatment of various diseases. Recommendations internationally accepted, namely by European Committee for Hyperbaric Medicine (ECHM), include pathologies that are common to adults and children. There is a huge lack of information regarding the use of HBOT in pediatric age.

Methods:
In this study AA carried out a retrospective analysis of medical records of all patients, aged under 18 years, referred to our Center during a ten years' period - January 2005 to December 2014. Descriptive statistical analysis of data was performed using SPSS version 20.0.

Results:
513 patients, aged 2 months to 18 years (mean 9.96 years) were treated in our Center. About 80% of patients were referred from carbon monoxide poisoning, 11.9% for sudden deafness, 2.7% for chronic osteomyelitis and 2.1% for chronic and refractory ulcer, among other quantitatively less significant pathologies. In our study, 4.5% of patients developed some kind of minor complications during treatment. A favorable response to treatment (HBOT) occurred in 87.5 % of cases (n = 449).

Discussion:
HBOT can be beneficial in many pathologies in children. Prevalence of diseases that led to HBOT in our Center CMSH is in accordance with previous studies. Treatment of CO poisoning should be more comprehensive in infants and children due to greater diagnostic difficulty and vulnerability to poisoning. Sudden deafness can have a negative effect on the quality of life and cognitive and social development of the child - HBOT may represent a beneficial treatment weapon. HBOT, in children, seems to be a safe therapy. Further studies are needed on the use of HBOT in pediatric age in order to account for the improvement that can be achieved with this therapy.

Keywords:
Hyperbaric oxygen therapy, Pediatric age, Carbon monoxide poisoning, Sudden deafness, Chronic osteomyelitis.

O-45 HYPERBARIC OXYGEN THERAPY FOR THE MANAGEMENT OF LATE-ONSET HAEMORRHAGIC CYSTITIS AFTER ALLOGENEIC BONE MARROW TRANSPLANTATION – A COHORT OF PAEDIATRIC PATIENTS.

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Introduction:
Haemorrhagic cystitis (HC) is a major cause of morbidity and extended hospitalisation in paediatric patients (ppts) who undergo haematopoietic stem cell transplantation (HSCT). Late-onset HC is present in 7 to 52% of the cases. We aim to explore the clinical effectiveness of hyperbaric oxygen therapy (HBOT) in ppts with HC after HSCT.

Material and methods:
Retrospective cohort analysis performed on ppts with confirmed HC after HSCT treated with HBOT at the Navy Hyperbaric Medicine Centre between 1998-2014. Medical records were reviewed. Patients received daily 75 minute sessions, with 100% oxygen at 2.5 Atmospheres. Evolution of macroscopic haematuria was used to analyse treatment efficacy.

Results:
Nine patients with median age of 13 years (range, 5-16), 6 males, were evaluated. Primary indications for HSCT were: acute lymphoid leukaemia (77.8%), myelodysplastic syndrome (11.1%) and Fanconi anaemia (11.2%). All ppts underwent allogeneic HSCT after conditioning chemotherapy (C-CT) and 3 of them did total body irradiation. Haematuria occurred 32 days (10-82) after C-CT; all patients developed haematuria grade 2 or 3, and 88.8 % developed GvHD. All except one patient had urinary polyoma (n=7), or adenovirus (n=2). Median time between haematuria and treatment with HBOT was 29.5 days (7-51). All patients achieved resolution of haematuria, after a median 15 sessions of HBOT (range, 10-30). Compared with adults treated at our centre, higher rate of resolution was achieved (100% versus 82%; $p<0.0001$). Eight ppts (88.8%) became negative viral load during/after HBOT. Two ppts (33.3%) discontinued HBOT, due to cancer progression and pulmonary infection. Three ppts (33.3%) died in follow-up, due to cancer relapse, severe GvHD and sepsis, respectively.

Conclusions:
Our study supports the use of HBOT as a good therapeutic option for paediatric patients with HC after HSCT. Prospective, randomised and well-controlled trials are needed to establish the definitive efficacy and safety of HBOT.

Keywords:
Hyperbaric oxygen, Haemorrhagic cystitis, Haematopoietic stem cell transplantation, Paediatric age

O-46 MANAGEMENT OF AN INFANT WITH CO POISONING AND HYPERBARIC OXYGEN

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Introduction:
We report the case of a ten-month old infant who presented with an acute exposure to Carbon Monoxide (CO) Poisoning.
Severe acidosis was documented at 6.84Kpa. Hypertonia, arching, twitching and posturing (AVPU score P) was also a significant clinical feature. Blood glucose was recorded at 20.3 mmol/l adding to the child's Haemodynamic instability. Hypoxic cerebral Insult to the brain regardless of causation can inflict lifelong disabling damage and neurological sequalae. The extent of the damage correlates with clinical outcome. Hypoxic insult to Children is known to be the most common cause of causing cardiopulmonary arrest. Additionally, seizure activity is strongly associated with a poor neurological outcome.

Method of Treatment:
Hyperbaric Oxygen with a standard US Navy Table Five (max 2.8 ATA) with an Amron Hood with a latex neck seal.

Results:
Significant recovery of end organ perfusion was evident; displaying alert behaviour, (A on AVPU score) smiling, recognising Mum, grasping objects, increased tone, all indicating correction of cerebral hypoxaemia and the prevention of further neuronal insult. Hyperbaric Oxygen Therapy reduces the half-life of CO significantly accelerates the clearance of CO from blood and neuronal tissue Hyperbaric Oxygen Therapy reduces the half-life of CO significantly accelerates the clearance of CO from blood and neuronal tissue.

Discussion:
Infants and children exposed to sub lethal levels of Carbon Monoxide are more susceptible to the effects of CO and are known to experience symptoms much sooner than Adult, infants have been reported to often experience sequalae such as developmental delay. As with foetal toxicity the optimal treatment of the infant with CO poisoning remain to be fully elucidated. However, there is consistent evidence of hyperbaric oxygen being an effective treatment

Keywords:
Hyperbaric Oxygen, Cerebral Hypoxia, Infant, Carbon Monoxide.

O-47 HYPERBARIC OXYGEN THERAPY IN PEDIATRIC PATIENTS IN THE YEARS 2007-2011: TREATMENT OF CNS DISORDERS

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Introduction:
The aim of the current study was to analyze the circumstances, results and side effects of hyperbaric oxygen therapy (HBOT) in pediatric patients with central nervous system (CNS) disorders.

Methods:
Retrospective analysis of pediatric patients (age under 18 years) who underwent treatment with HBOT in our center in the period between January 1, 2007 and December 31, 2011. Data were obtained from medical files. Evaluation of clinical status and outcome after its completion was done by the attending physician of the patient. Glasgow Coma Scale (GCS) and Glasgow Outcome Scale (GOS) were assessed before treatment and after.

Results:
Among total of 103 patients, who were treated with HBOT in this period for different indications, 29 cases of patients with CNS disorders (21 males, 8 females) were included in the study, most of them with severe traumatic brain injury (TBI) and hypoxic-ischemic encephalopathy (HIE). Mean time from injury to start HBOT was 23 days (median 15, range 4-120). The favourable outcome were obtained in 25/29 patients (86%). Mean GCS was increased by 4.2 points from 9.1 before starting of HBOT to 13.3 after HBOT. Mean GOS was increased by 1.1 points from 2.7 before starting of HBOT to 3.8 after HBOT. Patients with TBI in comparison to patients with HIE appear better final therapeutic result, the difference in the level of health improvement was statistically significant ($p = 0.013$). Serious health and life-threatening complications or side effects of treatment were not observed in any case.

Discussion and conclusion:
Provision of HBOT to seriously ill pediatric patients is feasible in large regional centers and it is associated with acceptable risk of generally minor complications. Although more research is needed, our results show a positive effect of HBOT in neurological disorders in subacute to chronic phase of injury.

Keywords:
Hyperbaric oxygen, Pediatrics, CNS damage, Clinical outcome

O-48 HOW CAN HYPERBARIC OXYGEN THERAPY AFFECT ON DIAPHRAGM AND RESPIRATORY FUNCTIONS?

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Introduction and Objective:
Hyperbaric oxygen (HBO2) treatment is widely accepted and its use is increasing. There are some concerns about side effects of hyperbaric oxygen which can lead to deterioration in respiratory function. The purpose of the study was to evaluate the effect of daily HBO2 therapy on pulmonary function and diaphragmatic movements.

Methods:
Patients diagnosed with wound healing problems were prospectively enrolled in the study. The patients were treated using a standard 100 % oxygen at 2.4 atmospheres absolute (atm abs) 90-minute protocol with two five-minute air breaks in a multi-seat hyperbaric chamber. The dynamic and static lung volumes, diffusion capacity, maximal inspiratory and expiratory pressures (MIP and MEP) were measured before and after the planned treatment table for each patient. The thickness of the diaphragm, tidal volume, and the movements of the diaphragm during deep inspiration were measured by thoracic ultrasonography. Results were compared using SPSS 17.0 statistical software.

Results:
The study group included 16 male, 6 female, a total of 22 cases and the mean age was 53.3 ± 10.0 years. It has been found that all dynamic lung volumes, total lung capacity, residual volume, and vital capacity increased significantly ($p < 0.05$) at the end. Other static lung volumes, MIP, MEP, and DLCO values did not change ($p > 0.05$). It has also been identified that increase in the thickness of the diaphragm, tidal volume, and the movement of the diaphragm during deep inspiration were significant after the treatment ($p < 0.05$).

Discussion and Conclusion:
Hyperbaric oxygen therapy did not impair the pulmonary and diaphragmatic functions. On the contrary, HBO may cause an increase in pulmonary and diaphragmatic functions. It is not well known whether this increase is long-lasting with the available data.

Keywords:
Pulmonary function, Hyperbaric oxygen, Diaphragmatic

O-49 PULMONARY EVALUATION AS DECISION FACTOR IN HYPERBARIC OXYGEN THERAPY

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Background:
Security is a key requirement in the prescription of Hyperbaric Oxygen Therapy (HBOT). Pressure changes during HBOT session, determine changes in ventilatory mechanics and physiological adaptations. Some respiratory diseases, namely asthma, chronic obstructive pulmonary disease (COPD), previous spontaneous pneumothorax or previous thoracic surgery, may represent contraindications to HBOT. To quantify the importance of Respiratory Medicine, in this clinical context, authors analyzed the profile of patients referred to our Center, particularly respiratory pathology background, regular therapy and causes of exclusion from treatment.

Material and Methods:
We performed retrospective analysis of medical records of 633 patients consulted between January 2014 and July 2015, to perform elective treatment. Statistical analysis of data was performed using mean and standard deviation.

Results:
Most patients were male (60.2%). Mean age was 55.87 15.81 years. 10
smoking habits. 133 patients (21%) had respiratory and allergologic disease history, especially Asthma / rhinitis (73), previous pulmonary tuberculosis (19) and COPD (15). Two reported previous spontaneous pneumothorax. 26 performed regular treatment (inhaled or oral therapy) for their respiratory disease. For clinical decision support 48 patients underwent pulmonary function tests (22 had abnormal functional pattern) and 51 performed chest computed tomography (CT). 98 did not have conditions to HBOT - 44 for lack of indication and 54 because of general contraindications. 26 were excluded (48.1% of contraindications) due to pulmonary clinical history, abnormal pulmonary function test (PFT) or abnormal chest CT. 36 started inhaled or oral therapy to optimize control of respiratory disease and therefore optimize tolerance to HBOT.

Discussion:
When prescribing HBOT, respiratory diseases should be screened early, as they may represent important cause of exclusion. PFT and imaging evaluation are appropriate support instruments in clinical decision. Pulmonary evaluation should be seen as an important decision factor in prescribing this type of treatment.

Keywords:
Hyperbaric Oxygen Therapy, Contraindications, Pulmonary evaluation.

O-50 WAS THE APPEARANCE OF SURFACTANTS IN AIR BREATHING VERTEBRATES ULTIMATELY THE CAUSE OF DECOMPRESSION SICKNESS AND AUTOIMMUNE DISEASE?

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All air breathing vertebrates are endowed with pulmonary surfactants, surface-active lipoprotein complexes formed by type II alveolar cells. Surfactants are deposited in clearly defined areas on the luminal aspect of blood vessels, producing hydrophobic spots. Gas nanobubbles measuring 5–100 nm form spontaneously on the smooth hydrophobic spot from dissolved gas. Bubbles nucleate and grow at these spots after decompression from high pressure. Proteins with hydrophobic regions circulating in the blood will adhere to the gas phase-plasma interface. Deformation of their secondary and tertiary configuration will present them as foreign molecules or autoantigens. Components of the intact protein which are also present in a deformed protein may be recognized as foreign too. This process is proposed as the trigger for autoimmune diseases. The presence of autoimmune disease in air breathing vertebrates, increased autoimmunity and the elevated risk of decompression sickness with age, as well as variable sensitivity to both diseases, can be matched with the appearance of surfactant spots. Eliminating these spots may provide protection against both diseases.

Keywords:
Autoantigen, Hydrophobic spot, Blood vessels, Nanobubbles, Autoimmune disease

O-51 GRADIENT FACTOR AND DECOMPRESSION SICKNESS: FINAL ANALYSIS OF DAN EUROPE DSL DATA BASE

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Introduction:
DCS can occur in SCUBA even if current decompression algorithms are respected.
This study aims at better understanding why this can occur by the study of the Gradient Factor in real DCS cases after "normal recreational dives" respecting the current "safe" procedures.
We also focus on some risk factors linked with bubble formation and DCS as emerging from the analysis of the DAN Europe Data Base.

Materials and Methods:
The recorded digital dive profiles of 327 DCI cases from the DAN DB were analysed.
The gradient factor (GF - Buhlmann ZHL16 C) at the end of every dive was calculated.
Several dive-related risk factor were considered and evaluated for bubble formation and DCS development.

Results:
An in-depth analysis of the GF Value of the 327 DCS cases showed that only eight cases (2.5%) had a GF > 1 and only 14 cases had a GF > 0.9 (4.4%). The majority of cases (236 -73.7%) showed GF values between 0.70 and 0.90.
46 cases (14.4%) had a GF lower than 0.70 and 10 cases (3.4%) lower than 0.60.

The 327 DCI cases affected females (37%) in a higher percentage than their presence in the DAN Data Base (17% - $P<0.05$) while the analysis of the entire DAN DB did not show a significant gender difference in bubble formation.
The DCI group age was significantly higher than the mean age in the DAN DB ($p<0.05$).

Conclusion:
These 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.

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

O-52 DETERMINATION OF INHERITED OR ACQUIRED FACTORS INVOLVED IN DECOMPRESSION SICKNESS: CREATION OF A DCS RESISTANT RAT STRAIN

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Introduction:
Decompression sickness (DCS) is a complex and poorly understood systemic disease caused by inadequate desaturation following a decrease of ambient pressure. It is commonly accepted that formation of circulating bubbles is linked with DCS appearance. However, strong variability between individuals is observed both for bubble formation and DCS occurrence. This inter-individual variability raises questions concerning genetic factors that may be involved in DCS occurrence. The aim of this study was to select a new strain of rats by resistance to DCS.

Methods:
An initial lot of 52 male and 52 female Wistar rats aged 11 weeks were compressed with air at a rate of 100 kPa.min^{-1} up to 1000 kPa absolute pressure (equivalent to a depth of 90 meters of sea water) and kept at maximum pressure for 45 min. Thereafter, decompression was performed at a rate of 100 kPa.min^{-1} before pausing for three decompression stops: 5 min at 200 kPa, 5 min at 160 kPa and 10 min at 130 kPa. Animals were then observed for one hour to detect any DCS symptoms.

Results:
As reported previously, this diving profile induced 66% of DCS, and 33% asymptomatic animals. The ratio DCS/asymptomatic was not initially different between males and females, although males were statistically heavier than females. Resistant rats were selected and bred to create a new generation of rats that were subsequently subjected to the same hyperbaric protocol at age 11 weeks. In three generations, the outcome of the dive significantly changed from 33% to 66% asymptomatic rats, both for males and females. Interestingly, survival in females changed sooner than in males.

Conclusion:
This study already offers strong clues about the inheritance of DCS resistance, and will focus in the future on genetic and physiological comparisons between the initial Wistar strain and the new resistant population.

Keywords:
Decompression sickness, Resistant strain, Rat

O-53 FACTORS INFLUENCING THE SEVERITY OF LONG-TERM SEQUELAE IN FISHERMEN-DIVERS VICTIMS OF NEUROLOGICAL DECOMPRESSION SICKNESS.

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Objective:
Numerous studies have been conducted to identify the factors influencing the short-term prognosis for neurological decompression sickness (DCS). However, the long-term sequelae are rarely assessed. The purpose of this study was to study the factors likely to influence the severity of the long-term prognosis.

Design:
27 Vietnamese fishermen-divers who 9 ± 6 years beforehand had presented a neurological DCS with a sequelary condition, were questioned and examined. The severity of the initial clinical profile was quantified using a severity score. The long-term sequelae were clinically evaluated by looking for a motor or sensory deficit or muscular spasticity, and by realising a severity score for the sequelae, targeted on gait and sphincter disorders.

Results:
An initial severity score of ≥ 15 is significantly associated with a risk of serious long-term sequelae [OR = 13.7 (2.4-79.5) 95%CI]. Furthermore, certain treatment practices such as in-water recompression greater than the depth of 17m are significantly associated with a larger number of serious sequelae. The intensive practice of non-standardised hyperbaric oxygen sessions over prolonged durations of 30±25.7 days and delayed after the initial accident (4±6 days' median delay) also seem to be unfavourable.

Conclusion:
This study establishes a link between the initial DCS severity and the long-term sequelae causing severe gait disorders and sphincter incontinence. Furthermore, this work suggests that certain detrimental treatment practices should be modified. During this field study, we also found that it was possible to improve the sequelary condition of these divers by offering them a personalised programme of self-rehabilitation.

Keywords:
Diving, Bubbles, Decompression sickness, Fisherman diver, Neurologic sequelae, Hyperbaric oxygen, In-water recompression, Rehabilitation

O-54 PROTECTIVE EFFECT OF ESCIN ON DECOMPRESSION SICKNESS IN RATS

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Introduction:
Bubbles formation in tissues and circulating blood due to inadequate decompression is a causative factor of decompression sickness (DCS). Intravascular bubbles act on endothelial cells and lead to subsequent biochemical cascade including inflammatory responses. Escin exhibits clearcut protective effects on endothelia. This study aimed to investigate the effect of escin on DCS in rats.

Material and Methods:
Escin was administered orally to adult male rats for 7 d (1.8 mg/kg/day) before subjecting to a simulated air dive. Vehicle rats received the same volume of 0.9% NaCl solution. Rats were compressed with air to 7 absolute atmospheres (ATA) and maintained for 90 min before decompressing linearly to ambient pressure in 3 min. Following decompression, the rats were monitored for signs of DCS over a period of 30 min. Blood and lung samples of surviving DCS rats were collected for further analysis.

Results:
The incidence and mortality of DCS were decreased in rats treated with escin than those treated with the vehicle (P=0.001 or P=0.0045). The latency to DCS in the Escin group was significantly delayed (P=0.001) and survival time of rats between the two groups was also statistically different (P=0.003). Escin ameliorated the changes in endothelial indices (E-selectin, ICAM-1, lung Wet/Dry ratio and NO), oxidative response (MDA) and inflammatory reaction (MPO, IL-6 and TNF-α) caused by DCS.

Discussion:
The results show that oral administration of escin exerted significant prophylactic effect in a rat DCS model, possibly due to its endothelial protective, anti-inflammatory and anti-oxidative properties. As a widely used agent, escin may exert beneficial effects on DCS for divers.

Keywords:
Decompression sickness, Endothelial injury, Anti-oxidative, Anti-inflammatory, Escin

O-55 DETECTION OF VENOUS GAS EMBOLI AFTER REPETITIVE BREATH HOLD DIVES IN A TARAVANA CASE

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Introduction:
Acute manifestations of neurological symptoms after Breath-Hold Diving (BHD-g) are well known and called "Taravana".
Recently bubble formation in BHD-g was confirmed in one spear-fishing and the similarity with DCI in SCUBA diving was evident.
The aim of this experiment was to look for any bubble formation during BHD-g in a larger number of subjects.
We also evaluate the theoretical application of modern decompression algorithms to BHD-g in view of a possible prevention of Taravana.

Materials and Methods:
Eighteen subjects were investigated by transthoracic echocardiography before and after a Breath hold diving training session of in a swimming pool allowing diving up to 40 m depth.
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 DAN Europe's original "Diver Safety Guardian" (DSG) dive simulator, normally used for SCUBA diving, and modified to simulate the specific characteristics of BHD-g.

Results:
We found occasional bubbles in five subject and high bubble grade (grade four EB) in one subject that also showed symptoms of Taravana during the test.
There was no significant difference in the computed inert gas accumulation between the six "bubblers" and the twelve "non bubblers" $p > 0.05$.

Conclusion:
Our investigation confirm that high bubble grades can occur in BHD-g, the new evidence of high bubbles grade in a real Taravana case confirms that the mechanism is similar to those involved in Scuba Diving DCI.
More so if we consider that real spear-fishing sessions frequently imply more severe exposure than the ones studied in our pool tests.
Our tests also confirm that the theoretical M-value based calculation approach cannot be used for BHD-g decompression stress estimation.

Keywords:
Taravana; Breath-Hold Diving; Diving; DCI

P-01 HYPERBARIC OXYGEN THERAPY TO REDUCE HYPERGRANULATION TISSUE ASSOCIATED WITH SELF-EXPANDING METAL AIRWAY STENTS (SEMAS) IN PEDIATRIC PATIENTS.

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Introduction:
Obstructing granulation tissue complicates placement of prosthetic airway stents in 33-57% of pediatric cases. Self-expanding metal airway stents (SEMAS) were placed and hyperbaric oxygen therapy (HBOT) was delivered post-procedure to minimize hypergranulation tissue.

Case Descriptions:
Case 1: A 2.5 year old tracheostomy tube dependent boy with congenital complete tracheal rings and history of 3 separate tracheoplasty reconstructions, experienced ongoing distal tracheal stenosis and obstructing granulation tissue despite conservative treatments included CO2 laser excision, topical mitomycin C, and corticosteroid injections. Prior tracheal SEMAS placements were all compromised by hypergranulation tissue. Starting postoperative day 3 following SEMAS replacement, daily HBOT (2.0 ATA 100% oxygen for 85min. with two 5min airbreaks) for 7 days was delivered. He has remained free of airway obstruction for 2 years and went on to tracheal tube decannulation after reconstruction of tracheostomal stenosis.
Case 2: A nine year-old girl with history of esophageal atresia and proximal H-type tracheoesohageal fistula had severe cervical tracheomalacia causing chronic cough, recurrent bronchitis and bronchiectasis. A SEMAS was placed and cough resolved for 2 months until removed. Following failure of external transcervical tracheopexy with external absorbable plates, a second tracheal SEMAS was placed. Obstructing hypergranulation tissue requiring repeated balloon dilatation and endoscopic removal of the stent developed within 2 weeks despite institution of corticosteroids and topical ciprofloxacin/dexamethasone. Starting postoperative day 1 following replacement of the SEMAS, she received 10 daily HBOT sessions (2.0 ATA 100% oxygen for 85min. with two 5min airbreaks). Bronchoscopy after 4 HBOT sessions showed markedly reduced endoluminal granulation tissue associated with the stent. Recurrence of stridor and cough developed at 3 weeks. Bronchoscopy revealed stent deformity without significant granulation tissue.

Discussion:
SEMAS can exert radial expansive forces inducing ischemia in surrounding cartilaginous and epithelial tissues. HBOT stimulates angiogenesis, fibroblast remodeling and may help reduce hypergranulation tissue formation associated with pediatric airway stents.

Keywords:
Hyperbaric oxygen therapy, Self-expanding metal airway stents (SEMAS), Granulation tissue

P-03 CO POISONING IN GENEVA IN 2015

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Introduction:
Beginning of 2015 we decided to start a study on patients admitted for carbon monoxide poisoning. Since 2011, 156 patients have been admitted and treated for this diagnosis and 23 cases for voluntary poisoning (14.7% over 5 years), with a peak in 2011 and 2012 at 23%. The purpose of this study is to compare the symptoms of accidental and voluntary poisoning. Hypothesis: there are more clinical symptoms on voluntary poisoning comparing with accidental poisoning.

Method:
Information is collected through a paper survey using institutional documents but also via comparisons and patients (when possible). It is then centralised and processed (Excel). Are explored: immediate and distant SpCO, HbCO on arrival at hospital, immediate and distant troponines, neurological and clinical signs.

Results:
Reference period: January 1, 2015 to december 31, 2015.
Number of patients admitted for carbon monoxide poisoning and taken care of by the consultation team in hyperbaric medicine (CHM): 40 of which 4 voluntary: 10%
Male/Female distribution:

- Accidental poisoning: 37.8% female, 59.4% male
- Voluntary poisoning: 50% female, 50% male.

Average age:

- Accidental poisoning: 37.8 years old, span 2/87
- Voluntary poisoning: 29 years old, span 14/33

Discussion:
This retrospective study about 2015 only deals with 4 out 40 patients and is not representative enough to confirm the original hypothesis:
Research over several years would be more evocative: However, all 40 patients clearly show major shortenings concerning diagnosis. In the paper survey for each patient, elements such as SpCO were not indicated in 50% of accidental poisoning and 75% of suicidal poisoning. Troponines were not carried out in 78% of accidental poisoning. This lack of information could mean data have been lost or were not carried out. It would be interesting to work on this anomaly to improve diagnosis right from the beginning, initial first aid to hospitalisation.

Keywords:
Carbon monoxide, Poisoning, HBO

P-04 HYPOVOLEMIC SHOCK SYNDROME AND NEUROLOGICAL FAILURE SYMPTOMS AFTER TWO RISKY DIVES: A CASE REPORT

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Background:
Dehydration is one of the most common causes of decompression illness (DCI) while diving. The typical clinical impressive neurological symptoms of the DCI distract from other symptoms such as an incipient hypovolemic shock.

Case presentation:
We present the case of a 61-year-old male Caucasian, who presented with an increasing central and peripheral neural failure syndrome and massive dehydration after two risky dives. A CT and MRI scan of his head and lung revealed multiple cerebral and pulmonary embolisms. A transesophageal echocardiography showed a patent (persistent) foramen ovale (PFO). The patient presented with hypotension as well as prerenal kidney failure with elevated levels of creatinine and reduced renal clearance, indicating a hypovolemic shock.
Early hyperbaric oxygen (HBO) therapy reduced the neurological deficits. After rehydration of eleven liters of electrolyte solutions (1000ml/h) the cardiopulmonary and renal function normalized.

Conclusions:
Dehydration increases the risk of DCI during diving, consequently the risk of hypovolemic shock increases. Early HBO - therapy and fluid replacement is crucial for the outcome.

Keywords:
Decompression illness, Hypovolemic shock syndrome, Dehydration, Hyperbaric oxygen therapy, Patent foramen ovale

P-05 TRAINING FOR NON-MEDICAL STAFF AT EUROPEAN HYPERBARIC FACILITIES

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Introduction:
Our aim is to assist non-medical staff who are employed at European Hyperbaric Facilities to achieve and maintain recognised levels of training.

Background:
The EBAss/ECHM Resource Manual (RM) details subjects required for adequate competence together with the levels to be achieved. Facilities conducting training are encouraged to gain accreditation for their courses from the EBAss/ECHM Joint committe. Finally, personnel who achieve a pass from an accredited course are eligible to attempt the EBAss independant on-line examination at their appropriate level.

Objectives:
Hyperbaric facilities are facing increasing demands to prove competence of their staff. Even now in most European Countries there is an understanding under Health and Safety law that employers will ensure their staff are competent, especially when carrying out duties that affect vulnerable individuals such as patients.
EBAss in association with the European College of Baromedicine (ECB) provides an independant accreditation system. Initialy there were two qualifications, European Certified Hyperbaric Chamber Operator (ECHCO) and European Certified Hyperbaric Registered Nurse (ECHRN). We now have added certification for personnel operating Monoplace chambers only, ECHCOM and, European Certified Hyperbaric Intensive Care Nurse (ECHICN).
Training centres can accredit their courses via the Joint ECHM and EBAss Accreditation Committee (JEEAC). The next step will be to introduce Safety Manager (SM) accreditation, this is planned to launch mid 2017.

Results:
The first result was the EBAss/ECHM Manual of Resources[2]. describing training, based on ECHM recommendations, for nurses, operators and technicians working in a hyperbaric facility. This document is intended to be a reference document for European countries. Our goals: are the Certification and Accreditation of all European Hyperbaric personnel.

Conclusion:
Our work is continuous and necessary; however, we always need more interest and commitment from the European hyperbaric community to increase the culture of continuous education in all European Countries.

Keywords:
Training, Non-Medical, Operator, Nurse, EBAss

References:
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[2] EBAss/ECHM Manual of Resources
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[4]www.ebass.org

P-06 LONG-TERM EFFECTS OF OXYGEN DIVING: CHANGES IN BODY COMPOSITION, VO2MAX, SPIROMETRY AND DIFFUSION CAPACITY

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Introduction:
Oxygen-rich gas mixtures, which are sometimes used in recreational and more often in professional diving may be able to induce certain pulmonary pathological processes, but evidence for oxygen-mediated long-term effects in divers is limited. The aim of this study was to assess changes in pulmonary and cardio-pulmonary parameters before start of oxygen-diving training and during active duty as an oxygen-diver.

Material and Methods:
221 healthy male volunteers (145 military oxygen-divers ((age 22.52±3.28yrs, BMI 23.87±1.95, body fat 14.95±5.19 %, VO2max 47.33±9.40ml/min/kg, 14.48% smokers)) and 76 military non-divers (age 27.49±8,54yrs, BMI 24.26±2.68, body fat 20.06±4.19% VO2max 44.55±9.32ml/min/kg, 34.12% smokers) were monitored during their annual medical assessments up to 13 years after primary investigation and beginning of professional oxygen-diving. Body-composition (BMI, body fat) was measured using bioelectrical impedance analysis (BIA). Cardio-pulmonary exercise capacity (VO2max) was analyzed by spiroergometry. Lung function parameters (Reff, VCmax, TLC, FEV1, Tiffeneau-index, FEF75%, FEF50%, FEF25%, diffusion capacity (RV%TLC-HE) were tested by bodyplethysmography.

Results:
Body-composition and exercise capacity showed typical age-related gradients in both groups. In contrast to non-divers, military oxygen-divers presented a significant decreased Reff after 3 years, which cumulated over a decade of 7 years. VCmax increased after 1 year and cumulated in both groups over the years, whereas TLC and FEV1 showed no differences. The Tiffenau-index decreased in both groups. In contrast to non divers, oxygen-divers presented with a significant drop in FEF50% and FEF25%, whereas FEF75% appeared stable in both groups. The diffusion capacity (RV%TLC-He) decreased in both groups, but remained reduced over time only in the oxygen divers.

Conclusion:
In contrast to previous studies there were significant changes in the Resistance (Reff), forced expiratory flow at 50% and 25% and the time course of the diffusion capacity, indicating oxygen mediated long-term effects.

Keywords
Oxygen diving, Lung parameters, Resistance, Diffusion capacity, Bioelectrical impedance analysis

P-07 INTESTINAL FERMENTATION COULD PROMOTE DECOMPRESSION SICKNESS IN HUMANS

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Introduction:
Massive bubble formation after diving can lead to decompression sickness (DCS) that can result in central nervous system disorders. During experimental dives with hydrogen as a diluent for oxygen, decreasing the body's H_2 burden by inoculating hydrogen-metabolizing microbes into the gut reduces the risk of DCS. Conversely, we have demonstrated that intestinal bacterial fermentation in rats on a normal diet promote DCS through endogenous hydrogen production. So we set out to test these experimental results in humans.

Materials and methods :
Between May 2013 and August 2015, 39 divers admitted to our hyperbaric facility for neurological DCS ("injured divers") and 39 asymptomatic divers ("healthy divers") have agreed to attend our study. Their last meal time and composition were noted. Intestinal fermentation was evaluated by measuring breath hydrogen, 1 to 3 hours after the dive.

Results:
Breath hydrogen was significantly higher among the "injured divers" (15±17ppm versus 7±9ppm; p=0.0078). At a cut-off value of 17ppm, we found a specificity of 87% (95% CI 73, 95) and a sensibility of 44% (95% CI 28, 60) for the prediction of neurological DCS development. We identified a strong association between hydrogen values below this cut-off point and the occurrence of neurological DCS (OR=5.3, 95% CI 1.8-15.7, p=0.0025). However, fermentation high potential food intake was not different between the "injured divers" and "healthy divers."

Discussion and conclusions:
Our study shows that intestinal fermentation level seems to be higher when diving, among injured divers. Hydrogen generated during fermentation and diffusing throughout the body could increase DCS risk. DCS prevention could pass through exclusion of divers with significant fermentation day of diving, elimination of gas produced in the intestine or even intestinal microbiota modifications to limit fermentation when diving. However, additional studies measuring fermentation long-term effects must be conducted before advising treatments generating sustainable disturbance of the intestinal microbiota.

Keywords:
Diving, Decompression sickness, Intestinal fermentation, Hydrogen.

P-08 SKISCUBASPACE PROJECT: HUMAN PERFORMANCE ALONG THE PRESSURE CONTINUUM

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Introduction:
"SkiScubaSpace" aims at starting a systematic, extensive and synergetic study on the similarities and differences of human exposure to extreme environmental conditions such as increase and decrease of ambient pressure, Neutral Buoyancy and microgravity, hypoxia and hyperoxia.
The impact on physiology and pathophysiology of musculoskeletal, nervous, circulatory, respiratory, digestive, urinary, and immune system and their interactions will be investigated using SCUBA Diving as a key point of reference and comparison.

Scuba and Space
While Neutral Buoyancy (Neutral Buoyancy Test Facility located at ALTEC, Turin) have supported astronautics since its very beginning, it is unquestionable that its use for simulating the absence of gravity is basically only empirical.
The condition of real absence of gravity will be obtained by parabolic flights and, possibly, using the International Space Station.
The scientific findings resulting from this project are expected to provide valuable information on the "management" of differences between the two conditions to distinguish effects and to "decode" physiological mechanisms.

SCUBA and Ski:
There are many well-known similarities between altitude and depth. If, on the one hand, pressure variations determine similar stresses on the organism, we cannot disregard the fact that, on the other hand, both situations cause particular hypoxia and hyperoxia conditions for cells and tissues to face.
It is not by chance that many of the diseases linked to these two conditions are similar, and linked to comparable genetic predispositions, as proven recently in studies conducted by DAN Europe.

Scope :
The scope of this presentation is not yet to show any result but to inform the diving research and medical community in view of possible cooperative actions.

P-09 YO-YO DIVING IN TRAINING PROGRAM OF FRENCH MILITARY DIVERS

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Introduction:
Yo-yo diving is a common practice in commercial diving (fish farm workers, harvest divers) traditionally recognized as a dangerous procedure, although some studies suggest that there is no evidence that this method produce a higher risk of decompression sickness (DCS) than that generally accepted by the diving industry (0.01-0.03% overall DCS incidence range). We therefore examine the characteristics and incidence of DCS in military divers trained to yo-yo diving during their course of "ship diver" in the French Navy diving school.

Material and Methods:
All the medical records and military statutory declaration forms concerning the student divers treated for DCS between January 2003 and September 2015 were retrospectively analyzed. Inclusion criteria were those who presented neurological symptoms or inner ear disorders following scuba air dives including a minimum of 3 bounces. Suspected cases of cerebral arterial gas embolism and inner ear barotrauma were excluded.

Results:
The study period captured 23 400 person-dives with 9 DCS cases that occurred after yo-yo diving, yielding an incidence rate of 0.038%. Mean age was 27 ± 3 years for a mean depth of 16 ± 2 msw and a mean bottom time of 40 ± 20 min followed by mandatory decompression stops of 1-min at 6 msw and 5-min at 3 msw (ascent rate 15 m/min). The median number of excursions to surface in any one dive was 5 [3-7]. Inner ear DCS was considered as the main injury (77%) with a median delay of symptoms onset of 30 min [1-120] after surfacing. All patients underwent hyperbaric oxygen treatment < 3 hours and none of them exhibited residual deficit. No DCS case was declared among diving instructors that used nitrox 40% as breathing gas during the same period.

Conclusion:
Yo-yo diving practiced in the French Navy diving school is a risky procedure for trainee divers. Future field studies are needed for the validation of safer diving profiles in this population.

Keywords:
Yo-Yo diving, Decompression sickness

P-10 SAVING LIMBS AFFECTED BY CRUSH INJURY OR SKIN AVULSIONS; HYPERBARIC OXYGEN OPTIMIZES HEALING

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Introduction:
Traumatic injuries such as skin avulsions, degloving and crush injuries cause severe damage to the tissues resulting in amputation of the affected limps. We want to report our clinical experiences of 7 cases who suffered from traumatic injuries with an increased risk of amputation and treated with hyperbaric oxygen (HBO) therapy after immediate reconstructive treatments.

Material and Methods:
It's a presentation of seven cases. Cases presented with injuries were admitted to the Hyperbaric Oxygen Treatment Center at our hospital. The wounds were localized mostly digits, hands or feet of the patients. Wounds characteristics ranged from necrotic slough, severe edema, to microvascular compromise findings. Adjunctive hyperbaric oxygen therapy was used to maximize the stimulus for graft revascularization in degloving and to decrease amputation risk of the limb. HBO was applied for 10 or 40 sessions in a multi-seat hyperbaric chamber (Hipertech Zyron 12). The treatment protocol consisted of 90-minute protocol daily sessions with 100 percent oxygen at 2.4 atmospheres absolute. The wound care dressings were replaced daily according to the needs of patients.

Results:
As a result, the outcome was favorable and HBO both significantly reduced the amputation risk and improved securing skin grafts placed around the defect. The patients well tolerated the treatment without side effects.

Discussion:
We believe that HBO is a useful adjunct in the management of severe traumatic injuries such as crush, avulsion, degloving of the limbs in patients. If the patient is treated immediately after the traditional treatments, the amputation and multiple surgeries may not be required.

Keywords:
Avulsion, Hyperbaric oxygen, Crush, Degloving

P-11 HYPERBARIC OXYGEN THERAPY IN AUTISTIC CHILDREN: REPORT OF 16 CASES

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Introduction:
Autism is a disorder characterized by an early deficiency in the overall development of cognitive, verbal and relational functions. In Tunisia its prevalence is estimated at 3.5 per thousand. The management of autism involves various therapies. However, none of these interventions is distinguished as the most effective. The search for new therapeutic approaches has led clinicians to experience hyperbaric oxygen therapy (HBOT) based on the demonstration that autistic children present cerebral hypo perfusion, a neuro-inflammation, oxidative stress that can be improved by this treatment.
The aim of this study was to evaluate the benefit of HBOT in the treatment of autistic disorder in children.

Materials and Methods:
This was a prospective study conducted in the HBO center of the military hospital of Tunis during a 6-month period from March 2014 to December 2014 including 16 children diagnosed with autism at the base of DSM IV-TR (Diagnostic and statistical manual of mental disorders, 4th edition criteria, revised text). All patients received 40 sessions of HBOT at a pressure of 1.5 ATA with 21% oxygen lasting one hour in a hyperbaric chamber. The evaluation was based on behavioral assessment scores: The Autism Treatment Evaluation Checklist (ATEC), the Childhood Autism Rating Scale (CARS) before and at the end of treatment with HBO.

Results:
This study included 16 autistic children (12 boys and 4 girls) with a mean age 5.8 years. Ninety-nine percent of patients were diagnosed before the age of 3 years. In this study 97% of children were receiving speech therapy, 50% occupational therapy, 43% attended a specialized center and 2 children were enrolled in first grade classes. A quarter of the children were under neuroleptics, 31% were under vitamins while one boy received a diuretic. The initial inflammatory balance of all children was normal. In our study the average ATEC score was 65.5 (25-97) the average CARS score was 41.6 (33-47). At the end of 40 sessions only 3 children showed improvement in their behavior, 7 were unchanged and 6 showed accentuation of their hyperactivity. There was no statistically significant difference in behavioral assessment scores (ATEC and CARS) before and after treatment by HBO.Monitoring to 6 months after stopping HBO is in progress

Conclusion:
We cannot conclude that there is a beneficial effect of HBOT in the treatment of autism given the small sample size and the lack of control group. Nevertheless, this study is worth pursuing despite the difficulty of access to center of HBOT and the constraints of time and cost.

Keywords:
Hyperbaric oxygen therapy, Autism, Behavior

P-12 AN EVALUATION OF THE REDOX STATE IN PROFESSIONAL SCUBA DIVERS

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Introduction:
Diving exposes individuals to environmental stress such as increased ambient pressure, a raised partial pressure of oxygen (O2), increased resistance to movement, added weight and the drag of diving equipment, cold stress, and a higher breathing resistance. Scuba diving could increase reactive oxygen species (ROS) production and thereby induce oxidative stress.

Material and Methods:
The study included 11 professional police divers during the training process – the dive training at sea. All examiners were male, 32 ± 5.1 years old, well trained. Testing was performed at the sea side, during the third dive training of professional police divers held in May. The specified depth was 30 meters, and specified duration of the dive was 30 minutes. Immediately before and after the dive, blood samples were taken from antecubital veins, from the divers in order to determine levels of pro-oxidant markers: superoxide anion radical (O_2•-), H_2O_2, nitrites (NO_2-) and TBARS, as well as antioxidant enzymes activity (SOD and CAT). Blood was centrifuged to separate plasma and red blood cells (RBCs). Biochemical parameters were measured spectrophotometrically.

Results:
The values of NO_2- were statistically increased after diving compared to the baseline conditions. The values of O_2•-, H_2O_2, TBARS, and antioxidative enzymes, CAT and SOD, were not statistically changed after diving compared to the baseline conditions.

Discussion:
Our results showed that values of NO_2- were statistically increased after diving compared to baseline conditions, while values of O_2•- and H_2O_2 remained unchanged. It is important to emphasize the short half-life of these parameters (except TBARS) which could affect interpretation of results. In study involved professional divers, we can assume that, due to frequent dives, their antioxidant systems had adjusted already, and thus new immersions did not lead to significant changes in these markers.

Keywords:
Scuba diving, Oxidative stress, Tests

P-13 HBO AS A CONTRIBUTION TO GOOD CLINICAL PRACTICE IN SURGERY

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Introduction:
Necrotic/gangrenous wounds are caused by ischemia and hypoxia. They are often associated with soft tissue infections and osteomyelitis. Usually occur in patients with diabetes mellitus, vascular insufficiency, after trauma, insect bites, after surgical procedures. Regardless of the etiology, if not treated properly and promptly, they often lead to amputation of the lower extremitiess.
HBO with main antiinflamatory, hypoxia corrective, angiogenesis stimulative and wound healing effects has an important role in necrotic wounds treatment.

Material and Methods:
During January and February 2016, four patients with necrotic wounds and infections were admitted in the CHM, Belgrade. They were referred by surgeons, 6 weeks after regular wound treatment. The wounds were different etiology-insect bites, lower leg injury, complication after surgery and complications of diabetes. All the wounds were located on a different part of patient legs.
HBO treatment was applied immediately after the examination. The treatment protocol included 100% oxygen at 2.5 ATA, 70 minutes per day, 25-35 exposures in total. Antibiotic therapy, regular dressing and wound debridement were also taken.

Results:
After the end of HBO, the infection was eliminated in all patients. In 3 patients the wound completely closed. In the fourth patient the necrotic tissue was removed and the bone was covered with granulation. There was not a single radical surgery.

Discussion:
The severity of necrotic wounds with infection requires early involvement in HBO, as well as the use of antibiotics and wound care treatment. Multidisciplinary approach to the treatment gives the best results. The clinical cases from our practice show the role and contribution of HBO in the treatment of necrotic wounds regardless of etiology. Timely, the introduction of hyperbaric oxygenation should necessary become a part of the protocol of good clinical practice in surgery.

Keywords:
Insect bite, Necrotic wounds, HBO

P-14 HBO IN THE TREATMENT OF LEG ULCERS DUE TO LIVEDOID VASCULOPATHY ASSOCIATED WITH THROMBOPHILIA– CASE REPORT

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Introduction:
Livedoid vasculopathy is an uncommon disorder characterized by chronic, recurrent and painful ulcerations of lower legs, feet and ankles that heal with atrophic stellate scars. The disorder most commonly affects young to middle – aged women with increased incidence during the summer. The exact etiopathogenesis remains unclear but is considered to be an occlusive thrombotic process due to a hypercoagulabile state. There is no effective treatment for this condition and current therapeutic options are based on isolated case reports or on case series.
The aim of this case report was to present the effect of HBO in the treatment of livedoid vasculopathy associated with thrombophilia (MTHFR gene mutation, homozygotus).

Material and Methods:
Female, 39 years old was admitted to the CHM Belgrade due to necrotic ulcers of both big toes. The disease was diagnosed 5 years ago and current changes have been present for the last 2.5 months during which she was treated with folic acid, salicylic acid, pentoxifylline and low molecular weight heparin but did not seem to respond to the treatment. She refused the proposed amputation of left big toe. Following the initial exam, the HBO treatment was introduced. The treatment included daily sessions of 100% oxygen at 2.5 ATA, for 70 minutes, 45 exposures in total.

Results:
The right big toe necrotic ulcer healed after 25 sessions of HBO. Clear demarcation and remarkable tissue preservation were seen of left big toe after completion of HBO therapy and the patient was released from pain.

Discussion:
Currently there is no satisfactory therapy available for this disease. Based on this case and previous successful treatment with HBO at the same patient, as well as earlier publications, HBO should be considered for livedoid vasculopathy therapy in future patients, especially when other treatment modalities have failed.

Keywords:
Livedoid vasculopathia, Necrotic ulcers, HBO

P-15 RESPIRATORY SYSTEM MECHANICS AND EXERCISE IN WARM WATER AFTER SCUBA AND REBREATHER DIVING

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Introduction:
It is known that the inspiratory effort is hindered by the hydrostatic pressure acting on the rib cage and that the hydrostatic pressure displaces peripheral blood toward the thorax causing lung vascular increased lung blood volume, which is known to affect respiratory system mechanics. In addition, muscular work during water immersion is also expected to affect spirometry performance, due to inspiratory/expiratory muscle fatigue, and possible exercise-linked influences. In a recent work was demonstrated that a head-out water immersion caused a worsening of spirometry performance, also including effort-independent indexes, namely maximum expiratory flows at 75%, 50% and 25% of vital capacity, which have not been extensively measured in the past.
The aim of the study was to monitor spirometry indexes in divers breathing at depth with different gas mixing during exercise, and to understand how this affect the respiratory work after surfacing.

Material & Methods:
The trials were conducted at Y-40 (Padova, Italy) in a pool with a water temperature of 31-32 °C. 5 healthy, volunteers and well-trained, male (age: 43.2 ± 10.2 yrs) divers participated to the study. The subjects performed the exercise test on an underwater bike (OKEO, Genoa, Italy) and the spirometry data has been measured by a turbine sensor of a portable spirometer (Pony FX, Cosmed, Rome, Italy), prior and immediately after the two tests standing out of water. The depth of the dive was set at 15 meters, where the subjects performed 20 minutes' effort on bike guided by Borg CR-10 scale at intensity level 3 (25 rpm). Two different experimental conditions were presented to the groups: (i) diving whyle breathing air (scuba); (ii) diving with a rebreather (1.4 ppO_2) (rebreather).

Results:
No significant differences between the two different experimental conditions were observed: different breathing mixture seem not to affect spirometric parameters immediately after exercise in warm water.

Keywords:
Spirometry, Respiratory mechanics, Diving, Rebreather

P-16 LUDWIG'S ANGINA: A CASE OF SUCCESS

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Introduction:
Ludwig's angina is a rapidly progressive, gangrenous cellulitis affecting the posterior oropharynx, submaxillary, and sublingual spaces. It usually arises following a dental extraction or infection and is potentially fatal due to airway obstruction. The management of Ludwig's angina involves antibiotics, maintenance of a secure airway and surgical drainage if necessary. Hyperbaric oxygen therapy (HBO) is indicated in some cases of severe infections.

Methods:
A 16-year-old female, ASA I, with the diagnosis of Ludwig's angina after a dental abscess, had to undergo an emergency surgical drainage of a submandibular abscess after 5 days of progressing disease. She maintained oedema and obstruction of the airway, with leukopenia and a CT scan showing an inflammatory process with air bubbles. She was transferred intubated, on day 8 from Terceira Island to S. Miguel Island 's hospital to undergo emergent hyperbaric treatment (anaerobics protocol). HBO at 2.8ATA with 75' O2 in 3 periods of 25' plus 25' at 2.5ATA.

Results:
She did 4 sessions of HBO. After the 4th session, she had to withdraw from the treatment because of a minor pneumothorax that resulted from the insertion of a central venous catheter in the jugular vein. At day 13 she was extubated and was discharge from the hospital on day 21 without any signs or symptoms of respiratory disease.

Discussion:
Ludwig's angina is a life-threatening disease with rapid involvement of the airway. HBO, as an adjuvant to the treatment, permits a more conservative management with fast and effective results.

Keywords:
Hyperbaric oxygen therapy, Ludwig's angina

P-17 A NEW LOG 6.7 PATHOGEN REDUCTION DISINFECTION CONCEPT IN HYPERBARIC MEDICINE

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Introduction:
The increasing need for keeping transmission of pathogens at minimum in a global fight against widespread infections do rise the effort of healthcare providers in these matters
A method that has been around for decades is vaporisation by hydroperoxide, But is looked upon as corrosive and therefore rejected by hyperbaric producers.
Fortunatly a new method have recently been introduced on the market by a Copenhagen CleanAir Company.
It is still a low grade of hydroperoxide (H2O2) but combined with peracetic acid (CH3CO3H) produced as a dry fog. This dry fog is noncorrosive and has been successfully used in the danish Royal Airforce C130 Hercules after transportation of Ebola virus contaminated patients.

Material & Methods:
Test site Karolinska University Research Multiplace chamber
Equipment; Mobiwatch Minibio, testsamples 6 pcs, controlsamples 2pcs.
Capacity of pathogen reduction is >Log6 (this will cope with future EU regulation).
The volume of the intended chamber room was calculated and according to this the required amount of solution was introduced in a plastic bottle. The bottle was attached to the suction pump in the rear compartment of the device A new calculation for the activated time needed plus one minute to close the room before starting the formation of the dry gas process.
The time calculated was 9 minutes of active time, followed by 4 hours of passive time and 10 minutes of airflow through the chamber.

Results:
The samples were brought to the test lab within 10 minutes from the termination of the test procedure. Apart from the control samples the test samples did show the expected Log 6.7 reduction of pathogens. Test samples; Geobacillus stearothermophilus (Mesa Labs n0 HMV-091)

Discussion:
A new disinfection concept of corrosive sensible equipment.

Keywords:
Disinfection, Non-corrosive, Ease of use.

P-18 ORTHOTOPIC LIVER-TRANSPLANTATION (OLT): HYPERBARIC OXYGEN THERAPY AS A SAFE AND EFFECTIVE THERAPY IN POST-OLT VASCULAR COMPLICATIONS.

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Introduction:
To date, in OLT clinical practice, Hyperbaric Oxygen (HBO_2) Therapy has mostly been used in case of Hepatic Artery Thrombosis (HAT): a devastating complication which consists in a complete interruption of arterial blood flow to the graft and almost always causes an irreversible damage.

Material and Methods:
At the Liver Transplantation Center in Turin (Italy) we have performed more than 2,850 transplants, until July 15th 2016, registering a 4.1% incidence of arterial thrombosis. In the period 2007-2016 (July), 30-patients (27-adults/03-pediatrics) were HBO_2-treated at the HAT, HAS or Substenosis stage, following one or more liver transplants. Six patients (5 adult, 1 pediatric) had already undergone a second transplant; one of them underwent a reOLT during the HBO_2 treatment protocol; in this case HBO_2 was used as a bridging solution, merely aimed to lead the patient up to a compatible liver. Excluded concomitant contraindications to HBO_2, the majority of treated patients has been exposed to 20 dives, lasting 90 minutes/each, @FiO_2=1, 1Tx/day, @2.5-ATA.

Results:
The cumulative survival curve for grafts (Fig. 1) reports, with a net significance ($p < 0.001$), that in case of a reduced blood flow (as it's in HAT / HAS) HBO_2 does prolong the survival of graft. In case of a new transplant HBO_2 can allow to postpone the reOLT option to a better stabilized clinical condition. On the contrary, the cumulative survival curve of patients (Fig. 2) does not yet allow ($p = 0.652$) a comparative evaluation between the effects of HBO_2-exposure on survival and what happens in the untreated.

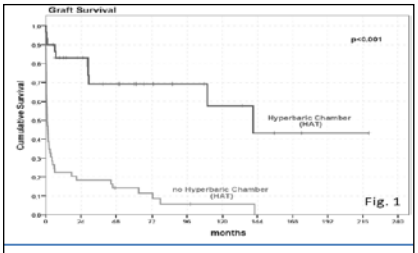

Fig. 1

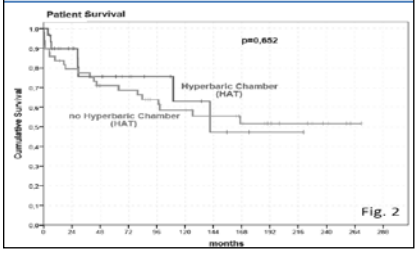

Fig. 2

Discussion:
This adjuvant treatment showed to be safe, well-tolerated, efficient.
Also in our experience HBO_2 turns out to be as the proper choice, when the clinical presentation suggests a conservative management, in controlling/reducing the severity of HAT, HAS or Substenosis after OLT. Moreover, from the direct experience on the ground, it sounds that the earlier HBO_2 is delivered in such cases the more effective it shows itself to be.

Keywords:
Liver Transplant, Hyperbaric Oxygen Therapy

P-19 DESIGN OF THERAPEUTIC HYPERBARIC CHAMBERS

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Introduction:
Therapeutic hyperbaric chambers have been in use from the mid-20th century, yet apparently their design has not reached their full potential and they are not compatible with current healthcare facilities design. We initiated on-going research projects on design concepts (initially presented ECHM, 2012) for improving the patients experience and service quality in hyperbaric treatments.

Objective:
To highlight problems and constrains of patients in therapeutic hyperbaric chambers from a human-environment-machine perspective, and suggest design concepts that may improve patient satisfaction, quality of treatment, and functionality of the staff; specifically, to investigate and renovate the central space of the therapeutic hyperbaric chambers.

Methods:
Data were collected from market survey of commercial internet sources of hyperbaric centers and hyperbaric chambers companies, professional reports, scientific publications and personal observations, evaluating the components of the interior space of the hyperbaric chambers: The sitting options, personal space, arrangement of the breathing apparatus, entertainment and communication systems. Different design solutions are presented including tradeoff considerations between patients and staff requirements.

Results:
Main solutions include improving the personal space, autonomy and privacy by re-arrangement of sitting layout, designing a personal space for the patient including the sitting object, tailored entertainment systems, personal multisensory communication system (visual, auditory and tactile) and orientation and time-line cues.

Conclusion:
It is suggested that adopting a user-centered design rather than an engineering focus will increase satisfaction and overall 'user experience' of the patients, alleviate psychological issues, and lessen workload and improve functionality of the staff. Some of these design concepts can be applicable and easily adapted to other confined therapeutic environments in which patients are restrained for several hours on a regular basis in receiving treatment, such as dialysis or chemotherapy rooms and for confined non-medical situations such as aircrafts and rapid trains.

Keywords:
Confined atmosphere, Healthcare facilities, Hyperbaric oxygen therapy, User-centered design, User experience.

P-20 FLOW MEDIATED DILATION EVOLUTION AFTER A NEMO33 SCUBA DIVE

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Introduction:
Previous studies have shown repeatedly that Flow-Mediated Dilatation (FMD) is significantly reduced after SCUBA diving. However, the extent and duration of this reduction vary widely between studies, which could be attributed to the dive profile and other environmental or physiological parameters. In previous studies done at the NEMO Brussels pool in calm, warm water conditions, FMD was measured at one time point post-dive, sometime between 30 and 90min post-dive. Here we study the evolution of FMD for over two hours post-dive as part of a larger collaborative study looking at multiple parameters for the same typical NEMO profile always used previously.

Methods:
17 divers performed a scuba dive at 30 msw (400 kPa), for 20 minutes of immersion time at NEMO 33 in Brussels. The brachial artery FMD was measured on a Mindray ultrasound scanner starting at 35min post-dive end and every 35min until 140min post-dive, always by the same experimenter (average of 3 measurements taken).

Results:
FMD was significantly reduced for the two first measures, at 35 and 70 post-dive minutes ($p < 0.05$) (Fig. 1)

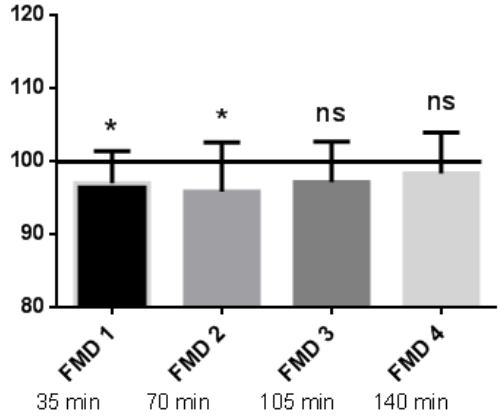

Fig. 1 – FMD post-dive (0min corresponds to the end of the dive), normalized to the 100% pre-dive value

Conclusion:
A significant FMD reduction is observed post-dive (35 and 70min post-dive respectively), which returns to baseline values progressively, achieving almost pre-dive values at 140min but is not significantly different from the 105min timepoint. Therefore, even for no decompression, no exercise, warm, pool conditions the oxidative stress of the dive remains for some time post-dive.

P-21 HYPERBARIC OXYGEN THERAPY IN THE MANAGEMENT OF DIABETIC FOOT INJURY: TUNISIAN EXPERIENCE

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Introduction:
Diabetic foot injury is a common complication in diabetes. It involves a complex pathophysioloy and requires multidisciplinary treatment approaches. The adjunction of Hyperbaric Oxygen Therapy (HBOT) is part of the multiple approaches in the management of this pathology.
The aim of our study is to assess the clinical, epidemiological and evolutionary characteristics of our population in order to determine the prognostic factors of patients treated with HBOT for diabetic foot injury.

Patients and methods:
This is a retrospective study including 318 diabetic patients treated in the HBO center of the military hospital of Tunis between 2010 and 2013.

Results:
The average age of our population was 61+/-11. The sex ratio was 2.8. Diabetic foot lesions were mainly classified as stage 3 (22.30%) and stage 4 (33.4%) according to Wagner classification. Most patients (80%) underwent hyperbaric treatment at 2.2 ATA during 60min. The average number of treatment sessions was 24+/-19 sessions. Only 242 patients finished their treatment. The outcome was favorable in 74.4% of cases with disappearance of infectious phenomena and appearance of budding stems. The uni-variate analysis showed that ASA score (P=0.031), peripheral arterial disease (P=0.005), kidney failure (P=0.041), heart disease (P =0.028) and depth of the lesion (P=0.045) were considered as poor prognostic factors whereas the number of HBOT sessions was a good prognostic factor (P=0.000).

Conclusion:
According to our study, HBOT is an effective adjunctive therapy for the treatment of chronic diabetic foot since it increases the cure rate and reduces the rate of amputation in the diabetic population.

Keywords:
Diabetic foot injury, Hyperbaric Oxygen Therapy, Prognostic factors.

P-22 ANALYSIS OF REAL DIVE PROFILES FROM THE DAN EUROPE DATABASE: SHOULD THE ASCENT RATE BE LOWERED?

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Introduction:
Dissolved gas phase tracking algorithms based upon variations of the Bühlmann ZHL16 are used by diving computer manufacturers worldwide. However, accidents happen without violations to these algorithms even in no decompression recreational diving.

Methods:
A MatLab decompression modeling platform implementing the Bühlmann ZHL16 algorithm is modified for analyzing real dive profiles, accounting for repetitive diving in the initial values of partial pressures for compartments. 105 no decompression recreational air dive profiles from the DAN Europe database were analyzed: 20 confirmed DCS cases, and 85 uneventful dives, all randomly chosen so that the years spanned and demographics did not differ significantly between the two groups.

Results:
Figure 1 shows the statistical comparison between the no DCS and the DCS groups.

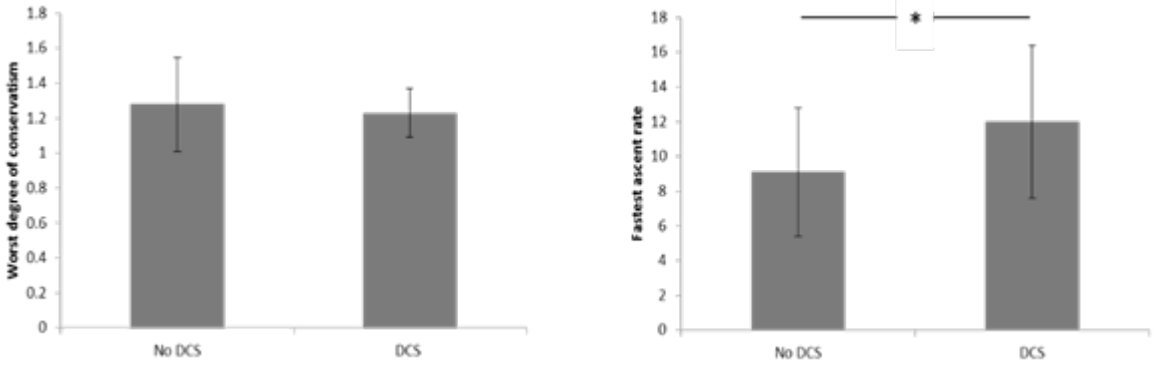

Figure 1: Left – Comparison of worst degree of conservatism (Student T-test) between DCS (1.28 ± 0.27) and no DCS (1.23 ± 0.14) groups; no significant statistical difference (p=0.456); Right – Comparison of fastest ascent rate (Mann-Whitney U-test) between DCS (12.0 ± 4.4 m/min) and no DCS (9.1 ± 3.7) groups; significant difference (p=0.0047)

Conclusion:
In the range of data analyzed the worst degree of conservatism does not play a significant role in causing DCS, however the ascent rate might. Suggestions for additional safety from our findings would be to lower the permitted ascent rate to 10 msw/min if further analysis with more profiles confirms the results. The lack of physiological data in current databases significantly limits the potential conclusions.

P-23 SURVEY CONCERNING HEALTH CARE FOR CO POISONING AT THE SKIKDA WARD, ALGERIA

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Introduction:
Due to the undeniable therapeutic efficiency of hyperbaric medicine in the treatment of several pathologies including CO poisoning, Algerian authorities have decided to set up 4 hyperbaric chamber units. We wish to evaluate health care for CO poisoning and use of hyperbaric oxygen therapy in the SKIKDA ward in Algeria.

Material and methods:
30 physicians who work at the emergency ward of SKIKDA hospital were asked to take a survey based on O2 normobare minimum treatment for CO poisoning, on HBO indication for serious poisoning and concerning pregnant women. The survey was filled in directly or by phone.

Results:
Only 40% of emergency physicians indicated hyperbaric oxygen therapy for serious CO poisoning, and only 12% for pregnant women. Moreover, only 12% applied a minimum treatment of 12 hours normobare oxygenation.

Discussion:
Lack of hyperbaric facilities in Algeria and of teaching time for this type of therapy during medical studies can explain lack of knowledge concerning HBO use. We realise, as in the case of many other regions that this results is in non optimal health care.

Keywords:
Survey, Normobaric O_2, Hyperbaric oxygen therapy, CO poisoning, Algeria

P-24 FIVE YEARS OF AN HYPERBARIC UNIT IN THE AZORES

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Introduction:
The Azores is an archipelago constituted by nine islands, having in total 246 772 inhabitants and a growing transitional population with the tourism boom that impelled the growth of diving in all islands. There are 3 Hyperbaric chambers in this archipelago, 2 chambers in hospitals working daily and 1 in a public health centre for emergencies only.
The main island, São Miguel, where this Unit is located, has 56% of the total archipelagos population and there are at least 6 certificated dive centres.
The unit it's located at the largest hospital of the archipelago and is a department of anaesthesiology service. It works daily, and is always in stand by for emergencies. It has a multiplace chamber that can accommodate one ventilated patient, or seven seated patients.
The aim of this study was to do a review of the Hyperbaric Unit (HU) work done in all areas of treatment that this hospital can offer.

Methods:
This is a study with data collected from the informatics process (Glintt® and PICIS®) in between 2010 and 2015 and Census 2011.

Results:
From 2010 to 2015 this unit has treated 315 patients, of those 28 where urgent treatments.
In this initial 5 years of the Unit existence the mean hyperbaric sessions per year was 299.
The major requests for treatment were: wound of difficult healing with 23%, diabetic foot with 21%, sudden deafness with 12% and burned patients with 11%.
The unusual cases were of ulcerative colitis, proctitis post-radiotherapy, ectopic eczema and Raynaud Syndrome with just one patient each.
The unit also treated 4 critical patients.

Discussion:
Through these 5 years there has been an increase of requests for Hyperbaric Oxigen Therapy.
The commitment of all team members and the improvement of equipment promoted a better and faster response for all the requests.

Keywords:
Azores, Hyperbaric Oxygen Therapy, Five years

P-25 MASSIVE CEREBRAL AIR EMBOLISM DURING PERCUTANEOUS LUNG BIOPSY SUCCESSFULLY TREATED WITH HYPERBARIC OXYGEN: TWO CASE REPORTS.

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Introduction:
Cerebral air embolism is a potentially life-threatening complication of percutaneous lung biopsy.

Methods:
We review two cases with iatrogenic air embolism after percutaneous lung biopsy and discuss pathophysiology, clinical manifestations, image findings and treatment.

Results:
Immediately after the procedure of percutaneous lung biopsy both patients had a rapid neurological and cardiovascular deterioration. Cerebral air embolism was suspected and the diagnosis was confirmed with CT-scan. Perfusion CT-scan was performed in case two, demonstrating grave hypoperfusion of the entire right hemisphere and the left occipital lobe. Hyperbaric oxygen treatment was initiated four hours after the incident (Table T6, 2.8 ATA x 285 min) in a multiplace ICU hyperbaric chamber. Patient #1 received two HBO sessions in total, whereas patient #2 received three HBO sessions, resulting in a complete neurologic recovery in case #2 and moderate disability in case #1. Patient #2 was thoroughly monitored with multiple CT-scans, perfusion CT-scan and MRI, thus making it possible to follow the development of the cerebral edema and the potential ischemic lesions and their regress later on.

The clinical decision making in these unexpected and dramatic situations was complicated, which resulted in some delay before the start of HBO treatment. A better awareness of iatrogenic cerebral air embolism would probably have shortened the time needed to initiate HBO.

Conclusions:
Early HBO treatment can be life saving and improve neurological recovery in cases of massive cerebral air embolism.

Keywords:
Hyperbaric oxygen, Iatrogenic complications, Cerebral air embolism, Emergency medicine

P-26 BIOCHEMICAL RESPONSE TO HYPERBARIC OXYGEN TREATMENT OF A TRANSHEMISPHERIC PENETRATING CEREBRAL GUNSHOT INJURY.

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Introduction:
Trauma-induced mitochondrial dysfunction contributes strongly to occurrence of secondary brain injuries and to adverse neurologic outcome in cases of traumatic brain injury. Hyperbaric oxygen is proposed as a possible treatment option in this condition, which has been confirmed in experimental animal studies.

Methods:
We studied a biochemical response to hyperbaric oxygen treatment in a patient suffering from penetrating transhemispherical gunshot wound; this kind of injury is associated with extremely poor prognosis. The patient was admitted to the Neuro-ICU and extensively monitored. Despite optimal surgical and pharmacological treatment, the patient developed catastrophic rise in lactate/pyruvate ratio (LPR), measured by intracerebral microdialysis (CMA70, µDialysis AB, Sweden). At the same time, cerebral oxygenation measured by Licox® brain tissue oximetry device ($PBtO_2$; Integra LifeSciences, NJ, USA) was normal. The findings were interpreted as manifestation of mitochondrial dysfunction. Normobaric oxygen up to 100% FiO_2 did not have effect on LPR or patient's neurological status. Three HBO sessions were then given at 2.8 ATA x100 min.

Results:
LPR decreased following the HBO treatments from 210 to 60 and then continued to slowly normalize. Intracranial pressure (ICP) and plasma levels of the brain injury marker S100b also started to normalize following the HBO treatment. The patient survived the injury with moderate neurological sequelae.

Conclusions:
HBO may be effective in correction of mitochondrial dysfunction or brain ischemia in TBI cases. The monitoring of a TBI patient in hyperbaric conditions presents some technical difficulties and must be carefully prepared.

Conclusions:
Hyperbaric oxygen, Traumatic brain injury, Neurosurgical Intensive Care, Cerebral metabolism

P-27 INCREASE IN T-CELLS AFTER HYPEROXIC EXPOSURE OF HEALTHY HUMANS IN VIVO WITHOUT RELEVANT INDUCTION IN APOPTOSIS

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Introduction:
In earlier experiments we have repeatedly shown that oxidative stress can induce dose-dependent DNA double strand breaks in peripheral blood mononucleocytes (PBMCs) in vitro and in vivo. In the present study we analysed whether this DNA damage induces changes in blood cell subsets and if the cells show an increased apoptosis.

Methods:
Before and after the mandatory hyperbaric oxygen exposure-test (280kPa, 30min) in a group of 23 male healthy applicants for the Navy Diving Units, we isolated PBMCs from blood samples. PBMCs were analysed for DNA strand breaks with the alkaline Comet Assay. Flow cytometry was used for determination of B- and T-lymphocytes and monocytes, identified by expression of CD3, CD4, CD14 and CD19, and combined with detection of apoptosis-induction (Annexin-V and 7-AAD).

Results:
Compared to the pre-exposure values, a significant 2.9-fold increase in cells with DNA damage was confirmed. Flowcytometric analyses revealed a significant increase of T-cells (CD3+ labelled, $p=0.001$; CD4+ labelled, $p=0.0082$), but no detectable changes in number of B-cells and monocytes. No relevant changes in apoptosis-induction in either cell population could be detected.

Conclusions:
In this study, we found a significant elevated DNA-turnover after hyperbaric hyperoxia, and an increase in CD3+ and CD4+ T-cell subsets without signs of a relevant increased apoptosis.
A possible explanation for the absence of apoptosis might be that PBMCs in peripheral blood are commonly resting and therefor not proliferating or that early DNA-repair prevents from cell death initiation. Further analyses regarding DNA-repair mechanisms and further differentiation of the increased T-cell subsets will be necessary.

Keywords:
Oxygen Diving, T-cells, DNA damage, Apoptosis

P-28 TEN YEAR EXPERIENCE OF THE ULS- MATOSINHOS HYPERBARIC UNIT (2006-2016)

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Introduction:
The Hyperbaric Unit of Unidade Local de Saúde Matosinhos was founded in 2006 and was the first civil hyperbaric chamber to operate in Portugal. This abstract aims to review its activity during the last 10 years.

Methods:
Patients processes were analysed in order to obtain data regarding treatments offered by the Unit from 2006 to 2016. Data was classified according to diagnosis and therapeutical outcomes. Statistical Analysis was performed using Microsoft Excel.

Results:
During this 10 years of activity it has treated 2077 patients (22.82 ± 15.70 years) for a total of 56 different diagnoses.
The top 10 diagnoses treated were: Sudden Deafness (662), Carbon Monoxide Intoxications (180), Soft Tissues Radionecrosis (157), Difficult Cicatrization Wounds secundary to inflammatory processes (143), Diabetic Foot Injuries (116), Radiation Proctitis/Enteritis (101), Anaerobic or Mixed Agents Infections (92), Refractory Chronic Osteomyelitis (89), Soft Tissues Radiation Injuries (46) and Jaw Osteoradionecrosis (37).
The protocols used for each intervention and an analysis of the efectiveness of the treatments will be discussed during the presentation.
Also, during the 10 years of activity, a strong effort on the divulgation of the Hyperbaric Oxygen therapies, namely with lectures in Medicine Schools, Post-graduate courses, participation in medical congresses, articles published in scientific journals and social media interventions.

Conclusion:
During the 10 years the unit has grown significantly and the interest and knowledge of the Portuguese physicians in the hyperbaric oxygen therapies has grown concomitantly.

Keywords:
Hyperbaric Oxygen Therapy, Sudden Deafness, Carbon Monoxide Intoxications, Soft Tissue Radionecrosis, 10-year experience.

P-29 SEIZURES INCIDENCE IN MORE THAN 150,000 TREATMENT SESSIONS WITH HYPERBARIC OXYGEN THERAPY - A SINGLE CENTRE ANALYSIS.

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Introduction:
Hyperbaric oxygen treatment (HBOT) involves some risk of central nervous system (CNS) oxygen toxicity, revealed by signs/symptoms including seizures in patients (pts) breathing O_2 at pressures ≥ 2 atmospheres (Paul Bert effect). The aim of this study was to determine the incidence of seizures and to assess the clinical benefit of a 5-minute air interval (5-AIR).

Material and methods:
17-year (1999-2016) retrospective analysis of all consecutive pts-treatments with HBOT at Navy Hyperbaric Medicine Centre. Pts received daily 75 minute sessions, with 100% oxygen at 2,5 atmospheres. Medical records were reviewed to determine the pts and seizures characteristics: comorbidities, type and timing (which and timing within session). Seizures incidence was compared among protocols with or without 5-AIR. Chi-square and Fisher 2-tail exact test were performed using SPSS (version 12.0); $p \leq .05$ was accepted as statistically significant.

Results:
We evaluated 161,313 HBOT sessions (74,367 from January 1999-July 2008; and 86,946 after 5-AIR establishment, until April 2016). Primary indications for HBOT were: peripheral vascular disease (n=19), chronic osteomyelitis (n=6), sudden deafness (n=6), radiotherapy sequelae (n=3) and soft tissue infections (n=2). Issued risk factors, several by pts: cardiovascular (n=32), high intensity trauma (n=6), chronic renal disease (n=3), cerebrovascular (n=2), autoimmune disease (n=2), neurological disease (n=1), active metastatic disease (n=1). Thirty-six pts, median age 54 years (range, 17-84), 25 males, 41 seizures - 29 before and 12 after 5-AIR (no difference among protocols, p=0,5). Seizures were classified as tonic-clonic generalised (n=34) and partial (n=2); it occurred at median 21st session (range 1-126), 3 occurred before halftime and underwent 3 sessions maximum.

Conclusions:
The seizure incidence, despite rare, is higher than other published data. Lower seizures incidence was achieved after 5-AIR, being noteworthy (12 out of 41), although without statistical significance. Assessing and defining the appropriate patients profile can be useful for further conclusions.

Keywords:
Hyperbaric oxygen therapy, Oxygen toxicity, Seizures.

P-30 CASE REPORT OF TARAVANA IN ELITE FREEDIVER

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Introduction:
Freedivers venture into the deep. Beyond 100 meters the risk of taravana or decompression sickness (DCS) increases. Also, repetitive dives increase the risk of DCS. To reduce the risk, appropriate recovery time is needed at the surface.

Methods:
An elite freediver was coaching a session with 5 dives in the range of 60 – 70 meter with divetimes between 2 and 2,5 minutes. The recovery time between the dives was 4 minutes. During the session a scooter was user for propulsion. After the last dive the freediver went back to shore and tried to stand up. He fell over a couple of times due to loss of balance. Help was offered including emergency oxygen.

Results:
The patient was treated in the local hyperbaric chamber. The initial neurological examination revealed complete loss of memory and stupor that lasted till 30 minutes into the treatment, a contracted right arm and a motor deficit on the complete right side. The hyperbaric treatment was a US Navy TT6 with extensions. After the treatment he still had balance problems, altered coordination test and a motor deficit on the right side. The patient was admitted to the hospital for the night and treated with 100% oxygen and IV. On day 2 and 4 follow-up treatments were given. The neurological examinations improved every day. With a complete remission of the balance problems and motor deficits. The coordination test was still abnormal. After 2 months the MRI and neurological examination showed no abnormalities. He is allowed to freedive again.

Conclusion:
The short recovery time between the dives, dehydration and tiredness of the freediver might be contributory to the taravana that happened. The scooter decreases the exercise in the water making the freediver feeling less exhausted after a dive, causing an earlier feeling of readiness for the next dive.

Keywords:
Taravana, Decompression sickness, Breath-hold diving, Freediving

P-31 CORTICAL BLINDNESS IN ACUTE CARBON MONOXIDE POISONING

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Introduction:
The post-intervallic syndrome (problems with memory, attention or concentration) can occur immediately after exposure to CO and persist, or these complications may be delayed. Cortical blindness is a very rare form. We report the case of a late cortical blindness due to severe CO poisoning treated with hyperbaric oxygen therapy.

Case report:
The patient was a 5 years old boy, with no history of previous neurological or other systemic disease was discovered unconscious by his mother in a confined room.
He was taken to the nearest hospital where he was given normobaric oxygen by mask after which he regained consciousness.
24 hours later, the child presented intracranial hyperpression symptoms. Initial Cranial CT revealed a bilateral and symmetrical occipito-temporal brain edema. Corticosteroid therapy was prescribed. After 15 days, he kept a significant decrease in visual acuity and alertness disorders. Ophthalmologic examination revealed no abnormalities in the eyeball. Brain MRI showed signal abnormalities of the gray matter inboth parietal and occipital cortex and also in the lenticular and the head of the caudate nuclei. The diagnosis of secondary cortical blindness to CO poisoning was retained. The child received 15 HBOT sessions. Vision progressively improved during the HBO treatment. Control MRI (after 1 month) showed partial regression in signal abnormalities.

Conclusion:
This case shows that adverse effects of CO poisoning may progress during the late period. We believe that HBO treatment remains effective and may prevent some of the neurological, neuropsychological, and visual sequelae from becoming persistent.

Keywords:
CO poisoning, Cortical blindness, Hyperbaric oxygen therapy

P-32 TRYING TO FORMALIZE RECOMMENDATIONS ABOUT CHILDREN'S SCUBA DIVING. THE SWISS WAY TO THE HOLY GRAAL.

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Introduction:
The question of children's scuba diving is highly debated, some institution allowing 5 years old children to dive and some articles being entitled « Should children be SCUBA diving? ». The Swiss Underwater and Hyperbaric Medicine Society (SUHMS) has tried to formalize recommendations for doctors, instructors and parents.

Methods:
We searched the literature for prospective or retrospective studies allowing firm conclusions about limits, contra-indications and precautions. The results being scant we had to resort to less evidence based means: physiopathology, analogies, development and psychology.

Results:
We focused our considerations on 4 axis:
A) Child's security must always be the first priority
B) Children's scuba diving should include educational aspects
C) Child's own development must be taken in account
D) Recommendations :
    1. Swimming ability.
    2. Easy access to diving site.
    3. Heat and cold protection (no dive if water temperature < 12 C°).
    4. Well sized equipment.
    5. Instructors and buddies. Instructors must be specially formed to work with children. After certification, the child must never be considered as a « normal » buddy, able to rescue an adult.
    6. Age, depth and duration. We recommend a minimal age of 8 years.
    7. Successive dives must be separated by a 6 hours' interval.
    8. An annual medical examination is necessary.
    9. A focused psychologic evaluation is necessary
    10. Contra-indications valid for adults are valid for children. Relative contra-indications for adults should be considered as absolute for children.

Conclusion:
As studies to base evidence based recommendations are lacking, we proposed a pragmatic and cautious approach based on physiopathology, analogies and child development. Nevertheless, further studies are highly needed to improve our knowledge and allow new, definitive and universally acceptable recommandations.

Keywords:
Child, Scuba-Diving, Recommendations

P-33 APPLICATION OF AN INNOVATIVE ELECTRICAL TECHNIQUE FOR THE DETECTION OF POST-DIVE ENDOTHELIAL DYSFUNCTION

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Introduction:
It has been shown that underwater diving may transiently decrease the post-ischemic flow mediated dilation (FMD), which is an indicator of endothelial functionality. This has caused some divers concern and raised questions about the safety of diving. Until now, FMD is studied with an ultrasound Doppler method that measures the diameter of brachial artery before and after a five-minute forearm ischemia caused by external compression with a blood pressure measurement cuff. After the five minutes of circulation occlusion, the flow through the artery increases and the artery diameter increases for about seven to 10 percent of its initial value.

Methods:
Herein, endothelial functionality is investigated by a novel device (Cor-IS) which is based on a patented electrical impedance spectroscopy technology (*European Patent Office, 3005942 A1, 2015*). A test campaign is performed in the NEMO 33 swimming pool in Brussels, Belgium. After ethical approval and informed consent, 17 volunteer divers are subjected to a well-defined dive profile at 33m depth for 20 minutes with water at 31ºC, while endothelial functionality is studied for 2h post-dive. Electrical measurements are conducted applying self-adhesive ECG pads at the forearm site of divers and are validated against ultrasound measurements.

Results:
Post-dive endothelial dysfunction is validated by both ultrasound (Doppler) measurements and electrical (Cor-IS) measurements.

Discussion:
The proposed device delivers promising results concerning endothelial dysfunction detection in humans, since Cor-IS measurements seem to be in fair agreement with the ultrasound ones. Further signal processing is currently carried out employing advanced algorithms (such as FFT/STFT, wavelets, spectrograms, HHT) in an effort to enhance endothelial dysfunction detection, identify the detection limits and classify obtained results.

Keywords:
Endothelial dysfunction, Electrical impedance spectroscopy, Signal analysis

P-34 CORRECTION FOR ADIABATIC EFFECTS IN THE CALCULATED INSTANTANEOUS GAS CONSUMPTION OF SCUBA DIVES

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Introduction:
In scuba diving practice, instantaneous gas consumption is generally calculated from the fall in cylinder pressure without considering the effects of water temperature (heat transfer) and adiabatic processes. We aimed to develop a simple but precise method for calculating the instantaneous gas consumption during a dive. The calculation was performed by measuring only three variables: cylinder pressure, depth and water temperature, all as a function of time.

Material and Methods:
With gas thermodynamics and water-gas heat transfer, the instantaneous released gas mass was modelled. In addition, five subjects made an open-water, air, open-circuit scuba dive to 32 metres' sea water. Depth, cylinder pressure and water temperature were recorded with a dive computer and gas consumption was calculated and compared using different methods.

Results:
After descent in open-water dives, the calculated gas mass in the cylinder was the same as calculated from cylinder data, suggesting that the model is adequate. Modelled dives showed that adiabatic effects can result in considerable overestimate of the gas consumption, depending on the dive profile, exercise-dependent pulmonary ventilation and the cylinder volume. On descending, gas thermodynamics are predominantly adiabatic, and the adiabatic correction of ventilation is substantial. During the dive, the adiabatic process (at the start 100%) decreases steadily until the end of the dive. Adiabatic phenomena are substantially different between square and saw-tooth profiles. The adiabatic effect will be illustrated with some actual dives under different conditions. In the emergency situation of a nearly empty cylinder after a square-wave dive involving heavy physical exertion, the adiabatic effect on the cylinder pressure is generally >20%. Then, with a strongly reduced consumption at the start of the ascent, heat inflow produces an increase of cylinder pressure and so more gas becomes available for an emergency ascent.

Conclusion:
Adiabatic effects, being indirectly dependent on exercise, the profile and other conditions, can be substantial. The developed method seems sufficiently accurate for research and sometimes for fatality reconstruction, and is implementable in dive computers.

Keywords:
Gas supply; Universal gas law; Thermodynamics; Models; Dive computers

P-35 TO HEAT OR NOT TO HEAT? AN INSIGHT FROM ARCTIC DIVING

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Introduction:
Thermal comfort of a diver plays a crucial role in terms of a safe decompression strategy and a diver´s performance. To keep diver's body temperature on the acceptable level while diving in cold waters, various heating systems are often used. However, little is known about the efficiency of a heating on diver´s mental performance. In the present study the effect of active and passive heating on cognitive brain function was evaluated during SCUBA diving in Arctic conditions.

Methods:
4 well-trained divers, participants of the Under the Pole II expedition, carried out 8 eCCR re-breather dives (1 dive per day) under the ice with average water temperature of -1.3°C. Dive profiles were kept constant as much as possible within the envelope of 20 min bottom time at 50 msw and total dive time of 60 min. Active heating or passive heating configuration was used during the dives. The pO_2 in the breathing loop was kept at 1.3 bar while breathing TRIMIX and at pO_2: 1.6 bar while breathing pure oxygen. Cognitive brain function was tested with Critical Flicker Fusion Frequency (CFFF) and PEBL Math Processing Test (MPT). Both tests were performed 60 min before the dive, at maximal depth, 5 min after gas switch at 6 msw, 30, 60 and 120 min after the dive.

Results:
The active electrical torso heating showed significantly positive effect on diver's surface temperature in the covered areas. CFFF did not changed significantly during all dives, however was significantly depressed 30 and 60 min after non-heated dives, compared to pre-dive values. MPT point to point analysis showed lower number of correct responses and higher number of incorrect responses 30 min after non-heated dives (compared to 6 msw measurement).

Conclusion:
Active electrical heating of divers has a positive effect on diver's thermal comfort and performance.

Keywords:
Diving, Brain, CFFF, PEBL, Heating

P-36 HOW COMPUTING HELPS EVALUATE THE TREATMENT OF CHRONIC WOUNDS

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Introduction:
Evaluating wounds, especially if they are chronic, and documenting them, are essential for treating patients. The practitioner's clinical exam will determine localisation, nature, characteristics and treatment of the wounds. The practitioner's experience as well as the many other people involved, are primordial. This actual evaluation is based on iconographic documentation, the advantage being possible retrospective, objective comparison with several pictures.

Material and methods:
The consultation team in hyperbaric medicine at the university hospitals in Geneva (Switzerland) has set up a protocol of weekly photographic monitoring of patients, using a graphic tool for image processing that can show the dimensions of the wounds and calculate their surface area. Internal procedures guide the user and guarantee the method's reproducibility. Once this was accomplished, the patient's computerised file is filled in; thus the information can be disseminated to all concerned medical partners while giving proof of the evaluation process.

Results:
The results of this project show the benefit and added value of digital photography coupled with an image processing application that gives precise, objective and comparable information about dimensions and above all surface area of wounds.

Discussion:
The limits of this method are related to the wound localisation and deepness that cannot be always well evaluated. Also the picture quality for the follow up depends on the nursing that will take them. The limits of this method is no way question the added value and transposed in practice to all health partners concerned in dealing with chronic wounds.

P-37 THE EFFECT OF HYPERBARIC OXYGENATION ON 7,12-DIMETHYLBENZ-ANTHRACENE-INDUCED (DMBA) CARCINOGENESIS IN WISTAR RATS

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Abbreviations: DMBA - 7,12-dimethylbenzanthracene; HBO – hyperbaric oxygenation

Introduction:
Breast cancer is the second most common type of cancer, and the fifth most frequent cause of death from cancer disease. The objective of this study was to examine the protective potential of molecular oxygen under hyperbaric conditions in rats after DMBA-induced breast carcinogenesis.

Material and Methods:
HBO effects were evaluated by monitoring the tumor incidence and analyzing biochemical and molecular markers in DMBA-induced breast carcinogenesis. The carcinogenesis was induced by a single intramammary injection of linseed oil and saline emulsion containing 25 mg of DMBA. After sacrificing animals, mammary gland, liver, lung and other organs were fixed and processed for analysis by light microscopy (stained by hematoxylin and eosin).
Studied animals were divided in four groups:

- G1 – DMBA + HBO started three days after DMBA administration during the following 4 weeks, 2.5 ATA for 90 minutes daily
- G2 – DMBA only
- G3 – intramammary 1ml of saline, after three days: HBO as in the G1 Protocol
- G4 – intramammary 1ml of saline

Results:
Ten weeks after the beginning HBO prevented 80% the formation of tumor - versus the G2 animals which, in the same percentage (80%), developed breast disease with metastatic changes. One malignant change without metastasis was recorded in one animal of G3. Identical finding with less local tumorous change was found in G4 animals. In G3 and G4 we noticed almost normally morphological structures in organs, while in observed G2 (less in G1) mammary gland and lungs, as one of the primary metastatic organ, displayed alterations of tissue with lymphoid cells, which were surrounding the lobules and secretory units of glands, blood vessels and airways.

Discussion:
Results indicate that HBO shows significant protectiveness from DMBA-induced carcinogenesis in rats, that is documented not only by the number of tumorous changes but also by significantly lesser deviation in biochemical and molecular abnormalities.

Keywords:
7,12-dimethylbenzanthracene, Carcinogenesis, Oxygenation

P-38 CERTIFIED ICU BED FOR USE IN MULTIPLACE HYPERBARIC CHAMBERS

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Introduction:
Since the introduction of quadro multiple chambers for treatment of critically ill patients, there has been a lack of a modern ICU bed suitable for use in hyperbaric environment. Some have tried existing models of different producers but there have been reports of unwanted actuation of functions.
This is of course a risk of patient safety.The work of a certification for the intended use for HBO needs a cooperative work with the producer, notified body and Karolinska Biomedical engineering department.

Material and Methods:
The principle to this is not so complicated but needs to be simple enough , not to complicate the workflow around the patient.
Together with the producers R&D department , product specialists a test bed with all the working parts put together in a test frame including battery and keyboard panels and remote control.
This made it possible to put it in the research chamber of Karolinska HBO facility.
The test protocol used are the same protocol that Karolinska have used for testing and certifying defibrillators, PDMS system and ventilator.
The test protocol is processed in both passive mode and active mode the verify the function of components and system integration. This in conjuration with the EN 14931 regulation. To this protocol a stresstest pressurisation cycle of rapid compression/decompression to5 bar gauge pressure

Results:
To the beds normal electrical circuitry a loop ending with a c circuit breaker intended for use in hazardous environment was installed
The intended use is to bring the bed into the chamber and before start of treatment put the breaker in HBO-position, thus isolating the battery from the bed .
The beds nonelectrical function CPR is not disturbed by this action.

Discussion:
Positive impact on patient safety and HBO treatment possibilities.

Keywords:
Intended use, Circuit breaker.

P-39 PLAN FOR A HEALTH (HYPERBARIC) CENTRE IN SOUTHERN SWITZERLAND 2016

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Introduction:
We present a plan to establish a hyperbaric centre at the Cardiocentro in Lugano, Ticino, Southern Switzerland. We enlist technical and administrative details to this goal and report a summary of the medical diagnoses recognized by the Swiss and foreign medical hyperbaric associations as well as by the Swiss insurances for inpatient and outpatient hyperbaric treatments.

Discussion:
We discuss the requirement of an hyperbaric centre and its possible utilization in Ticino, the Southern Swiss area where the Ospedale Regionale di Lugano and the Cardiocentro are located. In this respect we consider the local official medical statistics concerning those inpatient, outpatient and urgent medical diagnoses for which an hyperbaric treatment is indicated.

Keywords:
Hyperbaric centre, Southern Switzerland

P-40 HYPERBARIC OXYGEN THERAPY FOR TRAUMATIC ISCHEMIA: THREE YEAR EXPERIENCE OF A UNIVERSITY HOSPITAL

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Introduction:
Acute traumatic ischemia (ATI) involving crush injuries, compartment syndromes or threatened flaps is a condition where survival of the traumatized tissue is at risk mainly due to compromised circulation. Hyperbaric oxygen therapy (HBOT) has been recommended for these injuries in order to enhance tissue viability.

Methods:
Patients who were treated for ATI in our department from 1.1.2013 to 31.12.2015 were reviewed retrospectively. control group of non-HBOT patients could not be defined because this was an evaluation of the patients referred to our center for HBOT. Demographic data of patients, injury sites, injury cause, time to HBO treatment and outcomes were investigated. Relation between HBO timing, HBO sessions and outcomes were analyzed.

Results:
Seventy-five patients (18 female, 57 male) were treated for ATI. Mean age of patients was 28 and 37 % were less than 18 years of age. Sixty-four percent of ATIs was crush injury with open fracture. The most common causes of injury were trauma by falling object (49%) and car accidents (43 %). There were two patients injured in a bombing attack. The injuries involved the feet for forty (54%) of patients. Of these, twelve had digital sub-amputations. Three patients had multiple injuries. Time to HBOT after injury was less than 8 hours for thirty-three patients (43%), between 8 to 16 hours for 17 patients (23%) and more than 16 hours for the rest. Mean HBO sessions applied was 14. Seventy patients (93 %) healed without further major amputation.

Discussion:
HBO is a beneficial adjuvant therapy for traumatic ischemia management. Early referral and frequent applications in acute phase may improve the outcome. Further controlled studies are needed to assess the effects of variables.

Keywords:
Hyperbaric oxygen, Crush, Trauma

P-41 HYPERBARIC OXYGEN THERAPY IS AN ADJUVANT TREATMENT OF NECROTIZING EXTERNAL OTITIS

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Introduction:
Malignant (necrotizing) external otitis is an invasive infection of the external auditory canal and skull base, which typically occurs in elderly patients with diabetes mellitusand causes therapeutic difficulties. The aim of this study is to define the interest of hyperbaric oxygen therapy in the management of necrotizing external otitis

Methods:
This retrospective study involved 31 patients with necrotizing external otitis who received hyperbaric oxygen therapy from 2010 until 2014 in the military center of hyperbaric medicine of Tunis through a standedized protocol of 90 minutes at 2.5 ATA.

Results:
The mean age was 70 years (37-86 years). The sex-ratio was 2.8. All our patients were diabetics. Otoscopy found inflammation of EAC in all our patients with granulation tissue in 16% of cases. The microbiological sampling had a positive income in 35% of cases, identifying a Pseudomonas aeruginosa in 5 patients and a fungal agent in 3 cases. CT-scan showed bone erosion in 7 cases, an extension to the temporomandibular joint in 6 cases and an extension to the deep facial spaces in 7 cases. Bone scintigraphy with technetium 99m was performed in 12 patients (38%) showing increased uptake of the temporal bone. Quinolones associated to Ceftazidime were the most commonly used antibiotics in first-line treatment (86% of cases). Antifungal therapy was used in 6 cases.
All patients received HBO therapy within 2 months of evolution. The average number of sessions was 18 (2-60).
Healing was observed in 65% of cases, partial improvement in 20% and treatment failed in 25% of cases. Eighty-three percent of patients who underwent more than 10 HBO sessions were cured. No recurrence was noted.

Conclusion:
Hyperbaric oxygen therapy has shown itself to be a very useful adjunctive treatment in this disease process. While associated to medical treatment and effectivediabetes control it provides an obvious benefit in controlling theinfection and accelerates healing with no recurrence in diabetic patients.

Keywords:
Necrotizing external otitis – diabetes- Hyperbaric oxygen therapy

P-42 HYPERBARIC OXYGENATION IN THE TREATMENT OF RARE DERMATOSIS

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Introduction:
Pyoderma gangrenosum (PG), rare dermatosis of unknown etiology and different clinical manifestations, is a major challenge for the diagnosis and for the timely implementation of the appropriate therapy. The diagnosis is made based on the clinical presentation and exclusion of other diseases due to nonspecific histological findings. PG is characterized by a destructive, painful and progressive necrotic process. HBO was adopted as an effective treatment in the healing process, decreasing infection, and therefore found its place in the treatment of PG. The aim of this study was to present the effect of HBO in the treatment of PG.

Material and Methods:
A male, 58 years old, was admitted in the CHM Belgrade due to necrotic ulcer of right lower leg. A few days after the ulcer had appeared and despite the use of antibiotics, the necrosis spread, the temperature elevated and the pain increased. The patient was hospitalized in the department of plastic surgery, diagnosed as gangrene, as the result of insect bites. HBO was applied 10 days after hospitalization and 17 days after the occurrence of the ulcers. The treatment included 100% oxygen at 2.5 ATA, 70 minutes, twice a day, 30 exposures in total. The skin graft was performed too.

Results:
After the end of HBO, the infection was completely stopped and the necrotic ulceration which was extended to the entire lower leg and foot part was almost completely repaired. The patient was discharged without signs of infection, pain and fever.

Discussion:
The severity of PG requires early diagnosis and application of HBO without delay alongside antibiotic, corticosteroid therapy and surgical treatment. Considering necrotizing process, an example from our practice shows the importance of HBO regardless of etiology. A multidisciplinary approach to each patient is essential in diagnosis and therapy.

Keywords:
Pyoderma gangrenosum, Dermatosis, Hyperbaric oxygenation

P-43 ECHOCARDIOGRAPHY BUBBLE COUNTING AFTER A NEMO33 DIVE: THE NEED FOR CONTINUOUS ASSESSMENT

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Introduction:
It has been reported previously in one subject that the circulating gas bubbles in the blood assessed via ultrasound post dive vary over time, and it is known that bubbles can be observed for hours post dive. Here we investigate, as part of a larger collaborative study, the evolution of VGE for 2 hours following a standardized pool dive in calm warm conditions.

Methods:
17 divers performed a standardized scuba dive at 30 msw (400 kPa), for 20 minutes of immersion time at NEMO 33 in Brussels. Echocardiography assessment of VGE was performed at four timepoints post dive as per our published methodology.

Results:

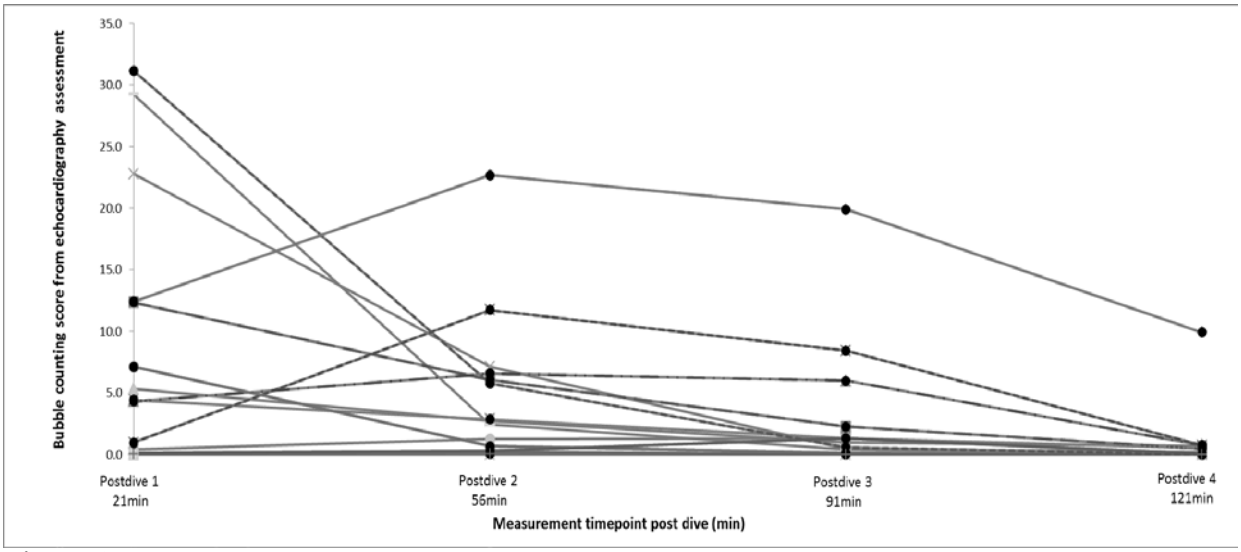

Figure 1: Evolution of bubble counting score post dive (17 subjects)

Discussion:
The evolution of VGE post dive clearly differs between individuals even when they have undergone the same dive profile. In particular, in divers for whom significant circulating bubbles are visible, the peak score varies and is observed at earlier or later time post dive. Future work on this data will look at correlations between the bubble score and other physiological parameters measured.

P-44 FIRST DIVE INTRODUCTION IN CHILDREN : HOW TO IMPROVE ACCESS AND SECURITY ?

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Introduction:
Recommendations about children's diving begin to be more formalized. First introductive dives, perceived as less dangerous have not been studied.
We propose some ways to optimize security and pleasure for children experiencing their first dive.

Methods:
As often with children's diving, literature to base strong recommendations is lacking. We found our way using pathophysiology, developmental milestones, cautiousness and ethics.

Results:
A) From a pathophysiologic point of view, the risks are somewhat different than in classical diving. Because of the small depth and short duration, bubbles cannot build up. Cardiac pathologies with shunts shouldn't be a contra-indication, as soon as the effort of swimming is allowed. Nevertheless, pressure differences are sufficient to cause pulmonary barotrauma and arterial gas embolism, as reported in the literature. Hence, history to detect obstructive diseases is of utmost importance.
B) The short duration of dive leaves very few chances of severe hypoglycemia in diabetic children treated by insulin, as long as glycemia before dive is superior to 6 mmol/l and 15 g of carbohydrates are given. In this case an insulin-treated diabetic child could experience diving.
C) The child should be 8 years old or more. No specific training exercise should be tried.
D) Protection form heat and cold must be provided.
E) Information is a right for the parents and a duty for the organizers. It should be provided in a written form. Detection of potential contra-indications is also enhanced by an ad-hoc form. We propose a model of document combining both.

An informal consultation with some instructors rose various reactions, from welcome to rejection.

Conclusions:
We propose recommendations to instructors about medical safety in organizing first dive introduction for children. Detection of obstructive respiratory disease is of utmost importance. Information and a short medical questionnaire is suggested. Acceptance by instructors could be problematic.

Keywords:
Child, First dive, Recommendations, Security

P-45 SAFETY RULES DURING HYPERBARIC TREATMENT

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With more than 3,000 sessions in 2014 and an increase in 2015, patient safety remains a constant priority of our hyperbaric therapy unit.

Hyperbaric therapy involves the administration of a therapeutic gas (usually O2) in a sealed chamber at superatmospheric pressures.

There are many risks associated with this therapy and it is up to us to prevent them.

Wishing to give our patients identical, clear and understandable information, we have created, in collaboration with the communication department of our hospital, a pamphlet with safety instructions to be followed during the hyperbaric treatment.

We were inspired by the documents made available to passengers on airplanes. This support illustrates the explanations provided by the staff of the facility during the first treatments.

After several changes, we have provided our patients with a first version for them to evaluate for us.

The assessment of the current document is done through a questionnaire, which will enable us to make improvements before the final version.

One of the first limits of the document is the language barrier.

We are planning to translate this document into several languages (English, German, Italian, Spanish and Portuguese).

This document will be available to all patients inside the hyperbaric chamber

Keywords:
Hyperbaric safety management

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