# EUBS 2011

European Underwater and Baromedical Society

# Book of Abstracts

37th Scientific Annual Meeting
August 24th – 27th, 2011
Gdańsk, Poland

Editors:
Jacek Kot
Zdzisław Sićko

EUBS European Underwater and Baromedical Society

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# Scientific Program

## 24th August 2011 – Wednesday

Satellite meeting:

▸ ECHM Workshop on HBO in Emergency Medicine

(09:00 – 15:00, Room A)

Satellite meeting:

▸ Workshop on Validation of Dive Computers

(08:00 – 16:30, Room B)

REGISTRATION: 15:00 – 18:00

WELCOME RECEPTION: 18:00 – 21:00

## 25th August 2011 – Thursday

OPENING CEREMONY: 09:00 – 09:30

**SESSION 1**

| | | |
|---|---|---|
| 09:30 – 10:30 | Invited lecture | **THE FOUNDATION OF OUR FUTURE**<br>*David Elliott (UK)* |

COFFEE BREAK: 10:30 – 11:00

**SESSION 2 (Hyperbaric medicine)** – Chairmen: *Daniel Mathieu, Maria Wujtewicz*

| | | |
|---|---|---|
| 11:00 – 11:45 | Invited lecture | **THE DISORDER SUFFERED BY FRYDERYK CHOPIN IN THE WINTER 1838-1839. AN ALMOST HYPERBARIC HISTORY**<br>*Jordi Desola (Spain)* |
| 11:45 – 12:00 | OP-01 | CARBON DIOXIDE MONITORING IN RESPIRATOR TREATED PATIENTS DURING HBOT, MEASURED BY ARTERIAL SAMPLES, END TIDAL CARBON DIOXIDE AND TRANCUTANEOUS CARBON DIOXIDE<br>*Bjerregaard A., Jansen E.* |
| 12:00 – 12:15 | OP-02 | DEFIBRILLATOR APPROVED FOR HYPERBARIC USE<br>*Kronlund P., Olsson D., Eriksson B., Lind F.* |
| 12:15 – 12:30 | OP-03 | 10 YEARS OF HYPERBARIC OXYGEN THERAPY IN THE HYPERBARIC AND SUBAQUATIC MEDICINE CENTRE OF THE PORTUGUESE NAVY MILITARY HOSPITAL –A SINGLE CENTRE ANALYSIS<br>*Alpuim Costa D., Batista Gomes I., Almeida S., Vera- Cruz P., Albuquerque e Sousa J.* |

LUNCH BREAK: 12:30 – 14:00 / POSTER EXHIBITION: 12:30 – 14:00

**SESSION 3 (Diving medicine)** – Chairmen: *Adel Taher, Ole Hyldegard*

| | | |
|---|---|---|
| 14:00 – 14:15 | OP-04 | RISK FACTORS AND CLINICAL OUTCOME IN MILITARY DIVERS WITH NEUROLOGICAL DECOMPRESSION SICKNESS: INFLUENCE OF TIME TO RECOMPRESSION<br>*Blatteau J., Gempp E., Constantin P., Louge P.* |
| 14:15 – 14:30 | OP-05 | USN TT5: IS STILL EFFECTIVE<br>*Brauzzi M., Tanasi P., De Fina L., Falini S., Sbrana G., Mambro A.* |
| 14:30 – 14:45 | OP-06 | POTENTIALLY TRAUMATIC EVENTS AND POSTTRAUMATIC STRESS REACTIONS IN RETIRED NORTH SEA DIVERS<br>*Troland K., Sundal E., Irgens A., Grønning M., Thorsen E.* |
| 14:45 – 15:00 | OP-07 | CLINICAL FEATURES OF DCS IN HYPERBARIC TUNNEL WORKERS AND TREATMENT OPTIONS ON SITE<br>*Faesecke K., Schlaich C.* |
| 15:00 – 15:15 | OP-08 | DECOMPRESSION SICKNESS TREATMENT IN A CLINICAL HYPERBARIC CENTRE – TWENTY YEARS EXPERIENCE<br>*Guerreiro F., Araújo A., Pinto C., Amaro C., Alves A., Branco J., Albuquerque e Sousa J.* |
| 15:15 – 15:30 | OP-09 | DIVER HEALTH SURVEY SCORE AND PROBABILITY OF DECOMPRESSION SICKNESS AMONG OCCUPATIONAL DIVE GUIDES AND INSTRUCTORS<br>*van der Hulst G., Buzzacott P.* |

COFFEE BREAK: 15:30 – 16:00

**SESSION 4 (Diving Medicine)** – Chairmen: *Jean-Michel Pontier, Dragana Ivkovic*

| | | |
|---|---|---|
| 16:00 – 16:15 | OP-10 | INFLUENCE OF PHYSICAL EXERCISE UNDER HYPEROXIC CONDITIONS ON PARAMETERS OF CEREBRAL BLOOD FLOW VELOCITY<br>*Koch I., Kähler W., Wohlrab C., Kowalski J., Meyne J., Koch A.* |
| 16:15 – 16:30 | OP-11 | RECREATIONAL SCUBA-DIVING WITH ENRICHED AIR NITROX: PULMONARY INJURY?<br>*Brebeck A., Muth T., Koch A., Kähler W., Balestra C., Schipke J., Deussen A.* |
| 16:30 – 16:45 | OP-12 | HEART RATE DURING RECREATIONAL SCUBA DIVING<br>*Brebeck A., Muth T., Koch A., Kähler W., Balestra C., Deussen A., Schipke J.* |
| 16:45 – 17:00 | OP-13 | COGNITIVE PERFORMANCE DURING SCUBA DIVING USING $O_2$-ENRICHED AIR<br>*Brebeck A., Schmitz-Pfeiffer H., Schipke J.* |
| 17:00 – 17:15 | OP-14 | CARDIOVASCULAR AND RESPIRATORY RESPONSES TO APNEA IN UNTRAINED MALES AND BREATH-HOLD DIVERS<br>*Narycheva I., Kuznetsov S., Rostovsky A., Popov D.* |
| 17:15 – 17:30 | OP-15 | ECG AND EMG MEASUREMENTS DURING DIVING USING A BASED DIVE COMPUTER: FIRST STEP INTO THE WEARABLE DIVE COMPUTER<br>*Ozyigit T., Memişoğlu M., Egi M.* |

# 26th August 2011 – Friday

**SESSION 5 (Diving Medicine)** – Chairmen: *Pasquale Longobard, Roswitha Prohaska*

| | | |
|---|---|---|
| 09:00 – 09:45 | Invited lecture | **FROM NAUTILUS TO DUBAI - A COMPRESSED JOURNEY**<br>*Noemi Bittermann (Israel)* |
| 09:45 – 10:00 | OP-16 | BIOPHYSICAL MODELS OF DECOMPRESSION : REVIEW AND PERSPECTIVES<br>*Hugon J., Blatteau J.* |
| 10:00 – 10:15 | OP-17 | PHYSIOPATHOLOGY OF DECOMPRESSION, PHYPODE PROJECT<br>*Guerrero F., Kot J., Marroni A., Germonpré P., Donda N., Angelini S., Dujic Z., Sieber A., Taher A., Meintjes J., Gardette B., Pontier J., Théron M., Garofalo G., Distefano G., Ljubkovic M., Cronje F., Sakr A., Balestra C.* |
| 10:15 – 10:30 | OP-18 | SWEDISH POLICY FOR DIABETES AND RECREATIONAL DIVING<br>*Örnhagen H., Adolfsson P., Jendle J.* |

COFFEE BREAK: 10:30 – 11:00

**SESSION 6 (Diving Medicine)** – Chairmen: *Constantino Balestra, Andreas Koch*

| | | |
|---|---|---|
| 11:00 – 11:15 | OP-19 | PLATELET MICRO-PARTICLES AND BUBBLE FORMATION DURING DECOMPRESSION AFTER A PROVOCATIVE DIVE<br>*Pontier J., Gempp E., Guerrero F.* |
| 11:15 – 11:30 | OP-20 | EFFECT OF OXYGEN BREATHING AND PERFLUOROCARBON EMULSION TREATMENT ON AIR BUBBLES IN ADIPOSE TISSUE DURING HYPOBARIC EXPOSURE AT 25 KPA<br>*Randsøe T., Hyldegaard O.* |
| 11:30 – 11:45 | OP-21 | BENEFICE OF OXYGEN BREATHING VERSUS PRESSURE ON BUBBLE REDUCTION FOR OPTIMIZING DECOMPRESSION PROCEDURE<br>*Blatteau J., Hugon J., Gempp E., Peny C., Vallee N.* |
| 11:45 – 12:00 | OP-22 | PROTEIN EXPRESSION PROFILES IN BRAIN AND PROTEIN S100B IN SERUM FOLLOWING HELIOX SATURATION DECOMPRESSION IN RATS<br>*Hope A., Havnes M., Bjørkum A., Stuhr L., Grønning M.* |
| 12:00 – 12:15 | OP-23 | PHYSIOLOGICAL EFFECTS OF RAPID REDUCTION IN CARBON DIOXIDE PARTIAL PRESSURE IN SUBMARINE TOWER ESCAPE<br>*Loveman G., Seddon F., Thacker J., White G., Jurd K.* |
| 12:15 – 12:30 | OP-24 | SENSORIZED REBREATHER MOUTHPIECE WITH INTEGRATED $O_2$ AND $CO_2$ SENSORS<br>*Sieber A., Krozer A.* |

LUNCH BREAK: 12:30 – 14:00 / POSTER EXHIBITION: 12:30 – 14:00

**SESSION 7 (Hyperbaric Medicine)** – Chairmen: *Folke Lind, Mirit Eynan*

| | | |
|---|---|---|
| 14:00 – 14:45 | Invited lecture | **HBO AND SEPSIS - MORE THAN INCREASED $O_2$ TRANSPORT**<br>*Peter Radermacher (Germany)* |
| 14:45 – 15:00 | OP-25 | MECHANISMS OF NITRIC OXIDE-DEPENDENT HYPEROXIC VASOCONSTRICTION<br>*Demchenko I., Allen B., Piantadosi C.* |
| 15:00 – 15:15 | OP-26 | THE EFFECTS OF THE HYPERBARIC OXYGENATION ON ANTIOXIDANT STATUS AND LIPID PEROXIDATION AFTER THE EXPERIMENTAL BRAIN INJURY<br>*Brkic P., Jovanovic T., Krstic D., Pekovic S., Colovic M., Mitrovic A., Lavrnja I., Dacic S., Bjelobaba I., Stojkov D., Parabucki A., Jovanovic T.* |
| 15:15 – 15:30 | OP-27 | EFFECTS OF HBOT ON SURVIVAL AND DIFFERENTIATION OF NEUROECTODERMAL CELLS WITH STEM CELL PROPERTIES IN CORTICAL INJURY MODEL<br>*Agoston V., Zadori A., Demeter K., Hadinger N., Varady L., Kohidi T., Göbl A., Nagy Z., Madarasz E.* |

COFFEE BREAK: 15:30 – 16:00

**SESSION 8 (Hyperbaric Medicine)** – Chairmen: *Maide Cimcit, Michal Hajek*

| | | |
|---|---|---|
| 16:00 – 16:15 | OP-28 | USEFULLNESS OF HYPERBARIC OXYGEN IN THE TREATMENT OF ACUTE ACOUSTIC TRAUMA<br>*Przewoźny T., Kot J., Narożny W.* |
| 16:15 – 16:30 | OP-29 | RETROSPECTIVE ANALYSIS OF 101 SUDDEN DEAFNESS CASES TREATED WITH HYPERBARIC OXYGEN IN 2010<br>*Caers D., Lafère P., Vanhoutte D., Germonpré P.* |
| 16:30 – 16:45 | OP-30 | TREATMENT OF COMPLICATIONS IN CARDIAC SURGERY WOUND HEALING WITH THE HYPERBARIC OXYGEN THERAPY<br>*Siondalski P., Jaworski L., Kołaczkowska M., Kot J.* |
| 16:45 – 17:00 | OP-31 | EXPERIENCES WITH ADJUVANT HBO THERAPY FOR SURGICALLY TREATED FRACTURES OF THE CALCANEUS<br>*Hasmiller K., Gabel J., Buettner J.* |
| 17:00 – 17:15 | OP-32 | RISK FACTORS ASSOCIATED WITH THE DEVELOPMENT OF OSTEORADIONECROSIS FOLLOWING EXODONTIA IN IRRADIATED AREAS<br>*Pepper J., Gaffney C., Oliver S., Cronin A., Bryson P.* |
| 17:15 – 17:30 | OP-33 | HYPERBARIC OXYGEN THERAPY FOR SCLERODERMA SYSTEMICA<br>*Polyakova L., Voronenkova E., Kuzovkina A., Apanasenko T.* |
| 17:30 – 17:45 | OP-34 | HYPERBARIC OXYGENATION AS AN ADJUVANT THERAPY FOR THE DIABETIC FOOT<br>*Jovanovic T., Omerovic I., Brkic P., Mitrovic A.* |
| 17:45 – 18:00 | - | *Open communications* |

BANQUET: 20:00 – 23:00 (BY INVITATION)

# 27th August 2011 – Saturday

**SESSION 9 (Pro/Con Debate)** – Chairman: *Peter Germonpré*

| | | |
|---|---|---|
| 10:00 – 11:00 | Pro/Con | Do we need different doses of HBO (time, pressure, frequency) for different patients and indications (except DCI)?<br>Presenters: *Daniel Mathieu, Wilhelm Welslau* |

**SESSION 10 (Pro/Con Debate)** – Chairmen: *Alessandro Marroni*

| | | |
|---|---|---|
| 11:00 – 12:00 | Pro/Con | In-Water Recompression vs Normobaric Oxygenation and Evacuation from Remote Location<br>Presenters: *Petar Denoble, Ulrich van Laak* |

COFFEE BREAK: 12:00 – 12:30

EUBS GENERAL ASSEMBLY: 12:30 – 13:30

CLOSING CEREMONY: 13:30 – 14:00

## 28th August 2011 – Sunday

Satellite meeting:

- DAN Divers Day

(08:30 – 17:00)

List of posters

| | |
|---|---|
| PP-01 | CAUSES OF DEATH AND CANCER INCIDENCE AMONG OCCUPATIONAL DIVERS IN NORWAY. *Irgens A., Troland K., Thorsen E., Grønning M.* |
| PP-02 | TREATMENT OF DECOMPRESSION INJURY IN CHILDREN, A SYSTEM FOR THE PATIENT AND THE PARENT. *Sifakis M., Jansen E.* |
| PP-03 | TREACHEROUS TREATMENT OR REASONABLE RISK? *Stephenson R., Bryson P.* |
| PP-04 | RISK-TAKING BEHAVIOURS AND DIVING INJURIES AMONG WESTERN AUSTRALIAN RECREATIONAL SCUBA DIVERS. *Buzzacott P., Rosenberg M.* |
| PP-05 | CASE STUDY: NEAR MAXIMAL VENOUS BUBBLE SCORES AND ARTERIAL BUBBLES WITH NO SIGNS OR SYMPTOMS OF DCS. *Blogg S., Gennser M.* |
| PP-06 | FATAL DIVING ACCIDENTS IN ALPINE WATERS: DOES THERE EXIST A RED THREAT? *Schipke J., Pacher A.* |
| PP-07 | DIVE ACCIDENT DURING DEEP DIVEX 2010 – MANAGEMENT AND OUTCOME. *Branco J. Guerreiro F., Alves A., Amaro C., Pinto C., Pereira S., Lopes L., Pereira C., Albuquerque e Sousa J.* |
| PP-08 | RAPID ASCENT AND BUOYANCY PROBLEMS IN WESTERN AUSTRALIA. *Buzzacott P., Pikora T., Rosenberg M., Heyworth J.* |
| PP-09 | MEDICAL ASPECTS OF DIVING WITH DISABLED PERSONS IN THE SULTANATE OF OMAN. *Prohaska R.* |
| PP-10 | PHYSIOLOGICAL AND PSYCHOLOGICAL CHANGES AND CHANCES IN HANDICAPPED DIVERS WHILE OUR DIVING COURSE. *Göbl A., Olaj-Békés E.* |
| PP-11 | EFFECTS OF RECREATIONAL TECH DIVING ON MEASURES OF RESPIRATION. *Döring K., Muth T., Schipke J.* |
| PP-12 | MYELOPATHY CASED DECOMPRESSION SICKNESS WITH SEVER EMBOLISATION. SUCCESFUL TREATMENT. CASE REPORT. *Paluskova M.* |
| PP-13 | NEW INSIGHT IN NEUROVASCULAR HEADACHE IN DIVING. *Snoeck T., Provyn S.,* Parlak B., *Emonts P., Clarys J., Sesboüé B., Balestra C.* |
| PP-14 | REDUCED ENDOTHELIAL FUNCTION BOTH IN SCUBA AND BREATH-HOLD DIVING, TWO DIFFERENT MECHANISMS? *Theunissen S., Guerrero F., Germonpré P., Balestra C.* |
| PP-15 | ARE ANTHROPOMETRIC POPULATION SPECIFIC PREDICTION FORMULAE ESTIMATING PERCENTAGE ADIPOSITY SUITABLE FOR DIVERS? *Provyn S., Scafoglieri A., Tresignie J., Lumé C., Balestra C., Clarys J., Snoeck T.* |
| PP-16 | COUNTERACTING THE INERT GAS NARCOSIS: THE OXYGEN EFFECT HYPOTHESIS. *Balestra C., Blondel L., Germonpré P., Lafère P.* |
| PP-17 | THE NORMOBARIC OXYGEN PARADOX: DOES IT INCREASE HB? *Theunissen S., De Bels D., Devriendt J., Germonpré P., Lafere P., Valsamis J., Snoeck T., Meeus P., Balestra C.* |
| PP-18 | ELECTRONICALLY VALIDATION OF GALVANIC O2 SENSORS. *Sieber A., Krozer A.* |
| PP-19 | A SAFE WAY TO DEFIBRILLATE INSIDE A PRESSURIZED HYPERBARIC CHAMBER. *Arnell P.* |
| PP-20 | HYPERBARIC OXYGEN FOR OSTEORADIONECROSIS OF THE FACIAL BONES: RETROSPECTIVE STUDY. *Amaro C., Pereira S., Costa T., Alves A., Paulo V., Branco J.,Guerreiro F., Albuquerque J.* |

| | |
|---|---|
| PP-21 | HYPERBARIC OXYGEN THERAPY USE AS AN IMPORTANT PART IN TREATMENT OF THE DIABETIC FOOT SYNDROME. *Leichenbergová E., Miček J., Palušková M., Nemcová Z.* |
| PP-22 | CLINICAL AND MOLECULAR EFFECTS OF HYPERBARIC OXYGEN IN DIABETIC FOOT ULCERS – PRELIMINARY DATA. *Mendes D., Fernandes T., Camacho O., Lima J., Soares R.* |
| PP-23 | A RETROSPECTIVE STUDY OF DIABETIC FOOT ULCERS TREATED WITH HYPERBARIC OXYGEN THERAPY. *Bishop A., Mudge E.* |
| PP-24 | DRAMATICALLY CLINICAL RECOVERY IN A PATIENT WITH FRONTAL LOBE NECROSIS AFTER CARBON MONOXIDE POISONING. *Karakuzu E., Metin S., Battal B., Oz O., Ocal R., Yildiz S.* |
| PP-25 | CASE REPORT: A SUCCESSFULLY TREATED CORTICAL BLINDNESS SECONDARY TO HEAD TRAUMA VIA HYPERBARIC OXYGEN TREATMENT. *Ergozen S., Yilmaz V., Yildiz S., Karakuzu E.* |
| PP-26 | HYPERBARIC OXYGEN THERAPY IN A LACTANT INFANT. *Pereira C., Guerreiro F., Albuquerque E Sousa J., Leal M., Barata D., Branco J., Alves A.* |
| PP-27 | HERPES ZOSTER OTITIS (RAMSAY HUNT SYNDROME) - CASE REPORT. *Stanojković V.* |
| PP-28 | SUDDEN HEARING LOSS: EFFECTIVENESS OF HYPERBARIC OXYGEN IN CASES WITH BAD PROGNOSIS. *Amaro C., Costa T., Pereira S., Radu L., Alves A., Vera Cruz P., Branco J.,Guerreiro F., Albuquerque e Sousa J.* |
| PP-29 | HYPERBARIC OXYGENATION FOR SUDDEN IDIOPATHIC SENSORINEURAL HEARING LOSS. *Gajic A., Kutlesic-Stevic S., Cejic D.* |
| PP-30 | ORGANIZATION AND 2-YEAR OUTCOMES OF THE FIRST STATE HOSPITAL-BOUND HYPERBARIC OXYGEN THERAPY CENTER IN ISTANBUL. *Oroglu B.* |
| PP-31 | EFFICACY OF HYPERBARIC OXYGEN THERAPY IN RADIATION-INDUCED HEMORRHAGIC CYSTITIS AND PROCTITIS. EXPERIENCE OF CRIS-UTH SINCE 2007. *Papoutsidakis E., Desola J.* |
| PP-32 | HYDROSTATIC PRESSURE EFFECTS ON RAT CNS CELLULAR AND MITOCHONDRIAL RESPIRATION. *Théron M., Hemmer C., Le Gal L., Belhomme M., Guerrero F.* |
| PP-33 | MODULATIONS OF CA2+ CURRENTS IN FROG PRESYNAPTIC MOTOR AXONS UNDER HIGH PRESSURE CONDITIONS: COMPUTER MODELLING. *Gradwohl G., Aviner B., Grossman Y.* |
| PP-34 | ALTERATIONS IN BLOOD GLUCOSE LEVELS IN RATS FOLLOWING EXPOSURE TO HYPERBARIC OXYGEN-INDUCED SEIZURES. *Eynan M., Krinsky N.* |
| PP-35 | HBO TREATMENT FOR THE RECOVERY OF MUSCLE INJURIES INDUCED IN RATS. *Cervaens M., Camacho O., Resende R., Marques F., Barata Coelho P.* |
| PP-36 | BIOPHYSICAL METHOD OF CORRECTION DISORDERS CAUSED BY HYPERBARIA. *Gulyar S., Olszański R., Skrzyński S.* |
| PP-37 | EXERCISE PARTICIPATION AMONG SATURATION DIVERS EMPLOYED IN NORWAY: A FOCUS GROUP STUDY. *Tangelder Y. C., Havnes, M. B., Gaustad, S. E., Møllerløkken A.* |

## Satellite meetings

### 24th August 2011 – Wednesday

Satellite meeting:

▸ ECHM Workshop on HBO in Emergency Medicine

(09:00 – 15:00, Room A, free registration*)

**SESSION 1**

| | |
|---|---|
| 09:00 – 09:30 | What is the level of awareness and education of emergency physicians concerning HBO?<br>*Juliusz Jakubaszko (Poland)* |
| 09:30 – 10:00 | How current European Standards for education and training prepare hyperbaric staff to deal with emergency care?<br>*Wilhelm Welslau (Austria)* |
| 10:00 – 10:30 | How HBO should be integrated in Emergency Department management?<br>*Erik Jansen (Denmark)* |

COFFEE BREAK: 10:30 – 11:00

**SESSION 2**

| | |
|---|---|
| 11:00 – 11:30 | Rationale for using HBO in burns.<br>*Peter Germonpré (Belgium)* |
| 11:30 – 12:00 | HBO in the treatment of burns: clinical experience.<br>*Michał Werner (Poland)* |
| 12:00 – 12:30 | HBO in the management of smoke inhalation.<br>*Daniel Mathieu (France)* |

LUNCH BREAK: 12:30 – 13:30

**SESSION 3**

| | |
|---|---|
| 13:30 – 14:00 | Emergency Management of DCI in remote areas: is there a role for IWR instead of NBO and evacuation to a treatment facility? A risk-benefit analysis.<br>*Nick Bird (USA)* |
| 14:00 – 14:30 | Acute ischemic ophthalmologic disorders.<br>*Jordi Desola (Spain)* |
| 14:30 – 15:00 | General discussion |

** Go to the www.EUBS2011.org for registration. Registration is free, but number of places is limited.*

# 24th August 2011 – Wednesday

Satellite meeting:

- Workshop on Validation of Dive Computers

(08:00 – 16:30, Room B, free registration*)

**SESSION 1 – Moderator: *Michael Lang***

| | |
|---|---|
| 08:00 – 08:15 | Introduction<br>*Andreas Møllerløkken* |
| 08:20 – 08:40 | Validation procedures<br>*R.W. Hamilton* |
| 08:45 – 09:05 | Dive computer considerations<br>*Karl E. Huggins* |
| 09:10 – 09:30 | Validation and standardisation<br>*Arne Sieber* |
| 09:30 – 10:00 | Discussion |

COFFEE BREAK: 10:00 – 10:15

**SESSION 2 – Moderator: *Michael Lang***

| | |
|---|---|
| 10:15 – 10:35 | Risk of DCS and US Navy validation process<br>*David Doolette* |
| 10:40 – 11:00 | Validation of dive computer algorithms<br>*Sergio Angelini* |
| 11:00 – 11:30 | Discussion |

LUNCH BREAK: 11:30 – 12:25

**SESSION 3 – Moderator: *Karl E. Huggins***

| | |
|---|---|
| 12:30 – 12:50 | The use of VGE to validate computers<br>*Christian Gutvik* |
| 12:55 – 13:15 | Dive computer use in recreational diving – DAN Europe<br>*Costantino Balestra* |
| 13:20 – 13:40 | Dive computer program management in scientific diving<br>*Michael Lang* |
| 13:40 – 14:10 | Discussion |

COFFEE BREAK: 14:10 – 14:30

**SESSION 4 – Moderators: *Michael Lang, Karl E. Huggins***

| | |
|---|---|
| 14:30 – 16:30 | Plenary discussion |

** Go to the www.EUBS2011.org for registration. Registration is free, but number of places is limited.*

# 28th August 2011 – Sunday

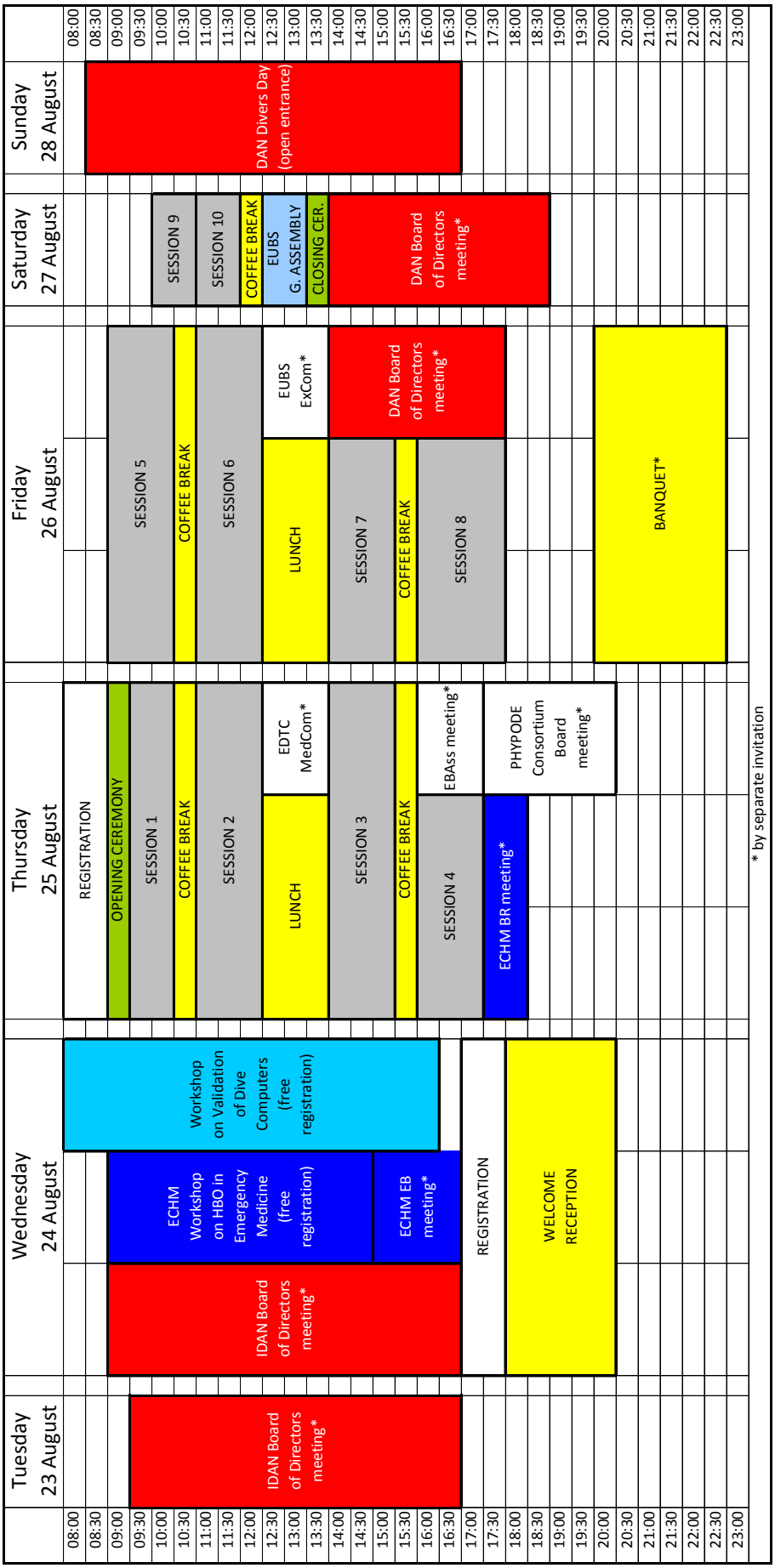
Satellite meeting:

▸ DAN Divers Day

(08:30 – 17:00, open entrance)

| **SESSION 1** | |
|---|---|
| 08:30 – 09:00 | Welcome and Introduction<br>*Alessandro Marroni and Nick Bird (IDAN)* |
| 09:00 – 09:45 | Recreational and commercial diving accidents - why the difference?<br>*David Elliott (UK)* |
| 09:45 – 10:30 | Recent Advances of DAN Europe Research on the pathophysiology of breath-hold and scuba diving<br>*Constantino Balestra (Belgium)* |
| | COFFEE BREAK: 10:30 – 11:00 |
| **SESSION 2** | |
| 11:00 – 11:45 | In-water recompression for diving emergencies in remote locations<br>*Ulrich van Laak (Germany)* |
| 11:45 – 12:30 | Diver Fatalities: How Good Divers Get Into Bad Trouble<br>*Dan Orr (USA)* |
| | LUNCH BREAK: 12:30 – 13:30 |
| **SESSION 3** | |
| 13:30 – 14:00 | Mechanics and causes of fatalities particularly in technical and rebreather diving<br>*Petar Denoble (USA)* |
| 14:00 – 14:30 | Oxygen in decompression<br>*Jacek Kot (Poland)* |
| 14:30 – 15:15 | The Divers Alert Network<br>*Guy Thomas (Italy)* |
| | COFFEE BREAK: 15:15 – 15:45 |
| **SESSION 4** | |
| 15:45 – 16:30 | DAN's Diving Medicine and Safety Programs: better awareness makes safer diving<br>*Francois Burman (South Africa)* |
| 16:30 – 17:00 | Participated Field Research in Diving Medicine and Physiology.<br>A powerful data collection system to complement classical Lab Research.<br>Methodology and recent acquisitions<br>*Alessandro Marroni (Italy)* |

## Time schedule



## Invited speakers and lectures

| | |
|---|---|
| Thursday<br>25th August 2011<br>09:30 – 10:30 | **The foundation of our future.**<br>*David Elliott (UK)* |
| Thursday<br>25th August 2011<br>11:00 – 11:45 | **The disorder suffered by Fryderyk Chopin in the winter 1838-1839. An almost hyperbaric history.**<br>*Jordi Desola (Spain)* |
| Friday<br>26th August 2011<br>09:00 – 09:45 | **From Nautilus to Dubai - A Compressed Journey.**<br>*Noemi Bittermann (Israel)* |
| Friday<br>26th August 2011<br>14:00 – 14:45 | **HBO and Sepsis - more than increased $O_2$ transport.**<br>*Peter Radermacher (Germany)* |
| Saturday<br>27th August 2011<br>10:00 – 11:00 | **Do we need different doses of HBO (time, pressure, frequency) for different patients and indications (except DCI)?**<br>*Daniel Mathieu (France)*<br>*Wilhelm Welslau (Austria)* |
| Saturday<br>27th August 2011<br>11:00 – 12:00 | **In-Water Recompression vs Normobaric Oxygenation and Evacuation from Remote Location.**<br>*Petar Denoble (USA)*<br>*Ulrich van Laak (Germany)* |

# Oral presentations

OP-01

## CARBON DIOXIDE MONITORING IN RESPIRATOR TREATED PATIENTS DURING HBOT, MEASURED BY ARTERIAL SAMPLES, END TIDAL CARBON DIOXIDE AND TRANCUTANEOUS CARBON DIOXIDE

Bjerregaard A.[1], Jansen E.[1]

[1] Department of Anaesthesia 4231, Rigshospitalet, Denmark

Keywords: Critical care, Research

*Objectives*

Determining end-tidal carbon dioxide ($PETCO_2$) as an estimate of the arterial carbon dioxide ($PaCO_2$) is an established part of the monitoring of intubated patients and is used during hyperbaric oxygen therapy (HBOT). Previous studies have shown that transcutaneous measurement of carbon dioxide ($PTCCO_2$) is more accurate than $PETCO_2$ during normobaric conditions. No studies have examined the precision of $PETCO_2$ or $PTCCO_2$ during hyperbaric exposure.

*Methods*

We studied 10 intubated and ventilatory stable patients during HBOT. End-tidal (M2501A, Philips, Netherlands) and transcutaneous measurements (TCM4, Radiometer, Denmark) provided continuous data. 1-2 arterial blood samples were collected per patient, the first a minimum of 20 minutes after reaching the operational pressure of 2.8 ATA and analyzed using a ABL700 (Radiometer, Denmark) located outside the chamber. Thus a total of 17 paired samples of $PETCO_2$, $PTCCO_2$ and $PaCO_2$ were obtained.

*Results*

There was a good linear correlation between $PETCO_2$ and $PaCO_2$ ($r^2 = 0.83$). Bland-Altman analysis showed that $PETCO_2$ on average was 2.22 kPa higher than $PaCO_2$ with limits of agreement (LoA) at ±2.4 kPa. By correcting for the linear correlation the LoA was reduced to ±1.5 kPa. $PTCCO_2$, on average, was 2.16 kPa lower than $PaCO_2$ and the linear correlation was poor ($r^2 = 0.24$). Bland-Altman analysis revealed LoA at ± 3.2 kPa.

*Conclusions*

During hyperbaric conditions we found that $PETCO_2$ as opposed to $PTCCO_2$ offered the greatest precision. However neither $PETCO_2$ nor $PTCCO_2$ delivers a precision that fully meets the demands of the clinical setting and further research into the challenges of hyperbaric monitoring is required.

OP-02

**DEFIBRILLATOR APPROVED FOR HYPERBARIC USE**

Kronlund P.[1], Olsson D.[2], Eriksson B.[1], Lind F.[1]

[1] Department of Hyperbaric Medicine, Karolinska University Hospital, Sweden
[2] Department of Biomedical Engineering, Karolinska University Hospital, Sweden

Keywords: Critical care, Equipment, Safety

*Background*

Our four-lock HAUX Quadro 3500 chamber system used since 2006 is CE marked for hyperbaric use (European conformity mark for medical devices). HBO treatment of critically ill patients necessitates special considerations regarding medical devices inside the hyperbaric chamber. With increased demands to deliver safe care, and with a growing number of unstable patients, we felt a strong need to develop a defibrillator approved for hyperbaric use. We first investigated available modern biphasic defibrillators for defibrillation of cardiac arrest. A risk analysis group was formed consisting of members from Karolinska University Hospital. In collaboration with the HAUX chamber manufacturer and the notifying body, Germanischer Lloyd, it was decided to avoid electrical connection through the hull of the chamber. The defibrillator is normally kept outside the chamber and locked into the chamber when needed. It can then be used bedside by our accompanying ICU doctor and nurse.

*Material & Methods*

The semi automatic Lifepak 1000 (Physio-Control), slightly modified was used. Three defibrillators were randomly allocated to go through repeated testing procedures in our research chamber. They were exposed to a significantly higher pressure (5 bar gauge pressure) than its clinically intended use according to standards.

*Results*

This cooperative work process, in collaboration with manufacturers interested in Hyperbaric Medicine, can help develop medical devices approved for hyperbaric use. We now have a certificate of approval issued by Germanischer Lloyd for using the slightly modified Lifepak 1000 defibrillator in the hyperbaric environment.

*Conclusions*

Work continues to have all our hyperbaric ICU equipment to comply with European codes and standards.

OP-03

## 10 YEARS OF HYPERBARIC OXYGEN THERAPY IN THE HYPERBARIC AND SUBAQUATIC MEDICINE CENTRE OF THE PORTUGUESE NAVY MILITARY HOSPITAL – A SINGLE CENTRE ANALYSIS

Alpuim Costa D.[1], Batista Gomes I.[2], Almeida S.[3], Vera Cruz P. [4], Albuquerque e Sousa J.[5]

[1] Hyperbaric and Subaquatic Medicine Centre of the Portuguese Navy Military Hospital, Portugal
[2] Hospital Santa Marta, Pediatric Cardiology, Portugal
[3] ITClinical, Lisbon, Portugal
[4] Otorrhinolaringology Service Director of Navy Hospital, Hyperbaric and Subaquatic Medicine Centre of the Portuguese Navy Military Hospital, Portugal
[5] Sub Director of the Portuguese Navy Hospital, Hyperbaric and Subaquatic Medicine Centre of the Portuguese Navy Military Hospital, Portugal

Keywords: Adverse effects, Data collection/analysis, Oxygen toxicity

*Objectives*

To analyse 10 years of Hyperbaric Oxygen Therapy (HOT) regarding population, efficacy, safety, comorbidities and side effects. One of the primary endpoints was to assess neurotoxicity due to hyperoxia clinically observed by the occurrence of seizures.

*Methods*

Retrospective systematic analysis referring to 8 main clinical indications, according to the European Underwater and Baromedical Society guidelines was performed. Elective and emergency indications were included in this study. All the enrolled patients were submitted to a 75-minute HOT in a multiplace hyperbaric chamber submitted to 2.5 atm. Collected data was statistically using appropriate software.

*Results*

During this decade, 90,688 treatments corresponding to 3,688 patients were subjected to systematic statistical analysis. Only 32 seizures concerning 27 patients were documented. This corresponds to a medium of incidence of 35.3/100,000 treatments in 10 years.

*Conclusions*

This high incidence may be explained by neurotoxicity in the patients on HOT due to vascular causes because they were exposed to a larger number of treatments and higher cumulative oxygen values.

Since October of 1989 HOT is carried out in the Portuguese Navy Hospital, the first and only hospital equipped with a hyperbaric chamber for several years. This is the most complete description, comprehensive and statistically study ever performed in Portugal and has shed new light on the standard of care in Portuguese HOT. Several clinical and research implications arise from the results of our study.

OP-04

## RISK FACTORS AND CLINICAL OUTCOME IN MILITARY DIVERS WITH NEUROLOGICAL DECOMPRESSION SICKNESS: INFLUENCE OF TIME TO RECOMPRESSION

Blatteau J.[1], Gempp E.[2], Constantin P.[2], Louge P.[2]

[1] ERRSO TOULON - IRBA, France
[2] SMHEP - HIA STE ANNE TOULON, France

Keywords: Data collection/analysis, Decompression tables/algorithms/procedures, Hyperbaric chamber/system/facility

*Objectives*

This study was designed to examine the influence of short delay to recompression and other risk factors associated with the development of severe neurological decompression sickness (DCS) in military divers.

*Methods*

Fifty-nine divers with DCS treated in less than 6 hours were retrospectively included. Diving parameters, symptom latency and recompression delay were analyzed. Clinical symptoms were evaluated for both the acute event and one month later.

*Results*

Median delay to hyperbaric treatment was 35 min (2 - 350 min). 25.4% DCS divers had incomplete resolution after 1 month. Multivariate analysis demonstrated that severe symptoms initially observed classified as sensory and motor deficits, or the presence of a bladder dysfunction were predictors of poor recovery. This study revealed also a relationship between a longer delay to treatment and incomplete recovery, but the increased risk appeared negligible.

*Conclusions*

Our results suggest that neurological severity upon occurrence is the main independent risk factor associated with a poor outcome in DCS military divers. The clinical recovery was not dramatically improved when recompression treatment was promptly performed in this series.

OP-05

**USN TT5: IS STILL EFFECTIVE?**

Brauzzi M.[1], Tanasi P.[1], De Fina L.[1], Falini S.[1], SbranaA G.[1], Mambro A.[1]

[1] Diving and Hyperbaric Medicine, Misericordia Hospital Grosseto, Italy

Keywords: Case report

*Objectives*

In 1965, Goodman and Workmann developed the current US Navy treatment tables. According to US Navy policy, USN TT5, the shorter oxygen table, is recommended for the treatment of type 1 decompression illness when symptoms are relieved within ten minutes at 2.8 ATA and a complete neurologic examination is normal or for omitted decompression. This study was undertaken to further evaluate whether the USN TT5 is an appropriate therapy.

*Methods*

From 2002 to 2010 in our facility we have treated 184 patients for decompression illness. We have reviewed their medical records.

*Results*

From 2002 to 2010 in our facility we have treated 184 patients for decompression illness. Of these 97 have been treated with USN TT5 (52.71%) with a complete recovery in 90 (92.78%). In the remainders the residual symptoms were very mild and were discharged after an average number of tailoring treatments of 1.5.

*Conclusions*

We can conclude that, in the view of the very high percentage of complete recovery, the uncomfortable and stressful nature of undergoing hyperbaric treatment, the increased costs of therapy with USNT T6, the use of TT5 can be still advised for the treatment of type 1 decompression illness when symptoms are relieved within ten minutes at 2.8 ATA and a complete neurologic examination is normal and for omitted decompression.

OP-06

## POTENTIALLY TRAUMATIC EVENTS AND POSTTRAUMATIC STRESS REACTIONS IN RETIRED NORTH SEA DIVERS

Troland K.[1], Sundal E.[2], Irgens A.[1], Grønning M.[1], Thorsen E.[1]

[1] National Centre of Hyperbaric and Diving Medicine, Haukeland University Hospital, Norway
[2] Department of Occupational Medicine, Haukeland University Hospital, Norway

Keywords: Adverse effects, Commercial diving, Long-term effects

*Objectives*

Diving poses a risk of death and injury. Many occupational divers have been involved in recovering dead bodies after disasters or accidents. In the literature on diving medicine, there are, however, only a few reports on long-term stress reactions in divers exposed to, or witnessing such potentially traumatic events.

*Methods*

Subjects were 220 former North Sea divers. They responded to a questionnaire by describing life-threatening events they had encountered or witnessed, and participation in recovering bodies or other disaster response work. The Impact of Event Scale- Revised (IES-R) was added to the questionnaire. The questionnaire was followed by a clinical interview. Two independent observers systematically categorized the events reported.

*Results*

Most participants (95%) had encountered one or more life-threatening events during diving. The events were categorized into 21 categories. The ones most frequently encountered were gas supply failure, entrapment/entanglement, proximity to falling objects and deviation of dynamic positioning. Sixty-three percent of the divers had participated in recovering dead bodies. The events most likely to cause posttraumatic stress reactions, as measured by the IES-R, were gas supply failure, water intrusion in bell or mask/helmet, entrapment/entanglement or being attacked or threatened by fellow divers or marine animals during diving operations.

*Conclusions*

In this sample of retired North Sea divers the majority had significant traumatic experiences. Certain types of events seem highly potent in causing posttraumatic stress reactions.

OP-07

## CLINICAL FEATURES OF DCS IN HYPERBARIC TUNNEL WORKERS AND TREATMENT OPTIONS ON SITE

Faesecke K.[1], Schlaich C.[2]

[1] HyperMedConsult, Hamburg, Germany
[2] Hamburg Port Health Center, Germany

Keywords: Commercial diving, Data collection/analysis

*Objectives*

About 160 years ago the first observations on a new illness manifestation were published, soon to be named "caisson disease". The signs and symptoms covered a range from simple skin discoloration to sudden death after reaching the surface. Due to safety regulations based on medical experience this has changed. The need for continuous development is outlined.

The intention of this study is to focus the discussion on treatment options other than the established US Navy tables.

*Methods*

In a retrospective study 14 own underwater tunnel projects in Central Europe applying work in compressed air between November 1988 and November 2010 were analyzed. Working pressures ranged from 1.8 up to 5.0 bar gauge.

*Results*

During 194 months of compressed air work a total of 14.468 individual exposures were logged, leading to 89 treatment cases of DCS. This represents an overall "bends' rate" of 0.6%. Compared to observations in the pre-tunnelling era a distinct shift in the preferred localization of complaints from the upper to the lower extremities was noted. 97% of cases were "pain only"-bends affecting the lower limbs in 95%. The distribution of joint vs. muscle pain was close to 1:1. Multiple areas of the body were affected in 75%; skin effects occurred in 9%. There were 3 cases of inner ear DCS. Other CNS manifestations were not observed.

Treatment of all cases took place on site, initially applying the standard US Navy tables 6 or 5. Following a serious oxygen convulsion in early 1998 these schedules were abandoned and replaced by the Comex 12-m-$O_2$ – table. All cases but 2 fully recovered and returned to work.

*Conclusions*

The application of modern tunnel boring machines worldwide has changed the appearance of caisson disease thoroughly. It is no longer the work-load that influences the localization of DCS symptoms but the conditions during the process of decompression. This is performed in small compartments inside the machine, called personnel locks, that forces the workers into a cramped posture not allowing the excess nitrogen of the lower extremities to be circulated to the lungs. The mandatory breathing of oxygen during this two-hour-period does not alleviate this problem. While the maximum depth of compressed air work world-wide is pushed further out there remains the need for medical research to protect the work-force by establishing safe decompression rules and effective treatment procedures applying as much pressure as necessary but as little as possible. These can no longer be limited to national regulations but must be agreed upon around the globe.

OP-08

## DECOMPRESSION SICKNESS TREATMENT IN A CLINICAL HYPERBARIC CENTRE – TWENTY YEARS EXPERIENCE

Guerreiro F.[1], Araújo A.[2], Pinto C.[2], Amaro C.[2], Alves A.[2], Branco J.[2], Albuquerque e Sousa J.[2]

[1] Subaquatic and Hyperbaric Medicine, Portuguese Navy Hyperbaric Center, Portugal
[2] Portuguese Navy Hyperbaric Center, Portugal

Keywords: Data collection/analysis, Recreational diving

*Objectives*

Analyse the profile of decompression sickness (DCS) cases, namely divers epidemiological data (sex, age, amateur or professional divers), origin of patients referral, dive depth, clinical symptoms, therapeutic tables and clinical evolution.

*Methods*

AA made a retrospective analysis of 86 decompression sickness cases treated in this hyperbaric centre between 1991 and 2010. Statistical treatment of data was performed using the mean and standard deviation.

*Results*

Most of the divers were men (93%). The average age was 33.83 ± 8.23 years (men 34.0 ± 8.33; women 30.5 ± 6.44). Large majority (89.5%) were amateur divers. Only 7% were professional and 3.5% were military divers. Most of the patients came from civilian Hospital's (73.3%). One patient was directly sent from a military ship. The average maximum depth was 28.64 ± 11.64 meters (10 went under 40 meters). Clinical findings, before performing Hyperbaric Oxygen Therapy (HBO), showed 42.6 % of the divers presenting mild symptoms – joint involvement – and 57.6 % presenting severe symptoms, namely neurological involvement. Most of the patients presented no symptoms after first treatment. 35 patients (40.7 %) needed routine HBO treatments after initial therapeutic session – the average of routine treatments performed was 8.51 ± 8.32 treatments. 10 patients (11.6 %) presented slight residual symptoms after completing treatment.

*Conclusions*

Due to stricter protocols followed by professional and military divers they usually suffer from less acute problems than amateur divers. Severity of clinical presentation influenced treatment duration. Clinical evolution was good in most cases.

OP-09

## DIVER HEALTH SURVEY SCORE AND PROBABILITY OF DECOMPRESSION SICKNESS AMONG OCCUPATIONAL DIVE GUIDES AND INSTRUCTORS

van der Hulst G.[1], Buzzacott P.[2]

[1] Dargaville Medical Centre, New Zealand
[2] School of Sports Science, Exercise and Health, The University of Western Australia, Australia

Keywords: Complications, Data collection/analysis, Recreational diving

*Objectives*

This study attempted to correlate self reported post dive Diver Health Survey (DHS) scores with computed daily probability of Decompression Sickness (pDCS) values as a measure of decompression stress in occupational divers in the recreational diving industry.

*Methods*

Divers completed the DHS form and their dive profiles were recorded electronically. The pDCS for each dive was calculated using the USN93 LE1 probabilistic model. Data were analysed using a mixed effects model.

*Results*

Mean daily maximum depth was 20.5m and mean total dive duration was 77 minutes. DHS was not significantly associated with pDCS. Mean DHS on non-diving days was 1.6 and increased by 0.8 for each dive made during any day. Mean number of daily dives was 1.9 and mean DHS on diving days was 3.1.

*Conclusions*

Occupational divers in this subset of the recreational diving industry are diving to deeper depths, for longer mean total daily duration underwater and repetitive diving more frequently than occupational tuna farm divers. These dive profiles generate more than twice the daily pDCS. Utility of the DHS for monitoring daily decompression stress among occupational divers working in the recreational diving industry in New Zealand remains unproven.

OP-10

## INFLUENCE OF PHYSICAL EXERCISE UNDER HYPEROXIC CONDITIONS ON PARAMETERS OF CEREBRAL BLOOD FLOW VELOCITY

Koch I.[1], Kähler W.[1], Wohlrab C.[1], Kowalski J.[1], Meyne J.[2], Koch A.[1]

[1] Section for Maritime Medicine of the Christian-Albrechts-University, German Naval Medical Institute, Germany
[2] Department for Neurology, University Medical Center Schleswig-Holstein, Germany

Keywords: High pressure biology, Oxidative stress, Oxygen toxicity

*Objectives*

Closed-circuit diving becomes more common, but high oxygen partial pressures can cause acute neurotoxicity with generalized seizures. The regular moderate decrease in cerebral blood flow velocity (CBFV) during hyperoxia is thought to be protective. It is unknown, if and how far physical exercise during hyperoxia may have an influence on CBFV and therefore may disturb the protective cerebral vasoconstriction.

*Methods*

Nine experienced male divers (27.9±9.5 years). 3 bicycle-ergometries in hyperbaric chamber (ramp protocol; begin 100W, increase 50W/min until heart-rate 170/min). Ergometry (a) at $pO_2$=0.21bar; (b) $pO_2$=1.0bar; (c) $pO_2$=1.5bar. Both-sided Transcranial Doppler ultrasound, ECG, continuous blood pressure monitoring in (a) and (b), during overpressure (c) not possible. Monitoring of end-tidal $CO_2$ ($PETCO_2$) during normoxic ergometry (a). $PETCO_2$-monitoring in (b) and (c) in closed-circuit was not possible.

*Results*

All divers reached comparable maximum workloads in the three ergometries (heart-rate 170/min and/or equal workload), maximum workload 4.18±0.87W/kg body-weight, with comparable blood pressure regulation in (a) and (b). $PETCO_2$ increased from 42.99±7.29 to 49.99±7.52mmHg (a). Systolic CBFV at rest vs. maximum workload increased in (a) from 65.03±11.27cm/s to 80.19±23.41cm/s (diastolic from 14.54±4,08cm/s to 15.56±7.48cm/s), in (b) from 58.15±16.49cm/s to 99.65±17.02cm/s ($p<0.001$) (diastolic from 13.98±10.7cm/s to 29.4±11.08cm/s ($p<0.01$)), in (c) from 54.35±14.97cm/s to 109.43±22.25cm/s ($p<0.001$), (diastolic from 14.7±10.41cm/s to 35.45±9.26cm/s ($p<0.01$)).

*Conclusions*

Systolic and diastolic CBFV decreased at rest with increasing $pO_2$. During physical exercise, however, systolic and diastolic CBFV showed significant increases with ascending pO2, although corresponding resting CBFV remained reduce. Physical exercise does not only neutralize the potentially protecting decrease in CBFV during hyperoxia, but leads to even higher CBFV-increases with ascending $pO_2$.

OP-11

## RECREATIONAL SCUBA-DIVING WITH ENRICHED AIR NITROX: PULMONARY INJURY?

Brebeck A.[1], Muth T.[2], Koch A.[3], Kähler W.[3], Balestra C.[4], Schipke J.[5], Deussen A.[1]

[1] Institute of Physiology, Technical University Dresden, Germany
[2] Institue of Occupational Medicine and Social Medicine, Heinrich-Heine-University Düsseldorf, Germany
[3] German Naval Medical Institute, Kiel-Kronshagen, Germany
[4] Environmental & Occupational Physiology Laboratory, Haute Ecole Paul-Henri Spaak, 1160, Brussels, Belgium
[5] Research group Experimental Surgery, University Hospital Düsseldorf, Germany

Keywords: Oxidative stress, Recreational diving, Research

*Objectives*

Hyperoxia can induce pulmonary injury via an increase in oxidative stress. The main objective of the study was to investigate, whether oxygen enriched air (=Air28) during diving induces pulmonary injury.

*Methods*

In a prospective study on 108 volunteers (female: 38) in the Red Sea (Subex, El Quesir, ET) static and dynamic pulmonary measures assessed (Jaeger Modern PC-Spirometer, Cardinal Health) before and after almost identical dives (depth: 24±1 m; duration: 62±5 min). 54 volunteers each were randomly allocated to either the air group or the Air28 group ($pO_2$: 28%). As representative measures, we chose: vital capacity (VC), forced expiratory volume in 1 s (FEV1) and peak expiratory flow (PEF).

*Results*

The predive VC in the entire cohort was 5.0 l, i.e. 8% higher than nominal. Postdive VC was almost unaltered (all: 98 %; air: 99 %; Air28: 98 %). Likewise, dynamic measures were almost unaltered: FEV1: all: 77±7 %; air: 78±7 %; Air28: 76±6 % (mean±SD). Predive PEF was slightly above nominal values (+3 %) (all: 8.8±2.2 l/s; air: 8.5±1.8 l/s; Air28: 9.1±2.6 l/s), and postdive PEF was almost unaltered (all: +1 %; air: +5 %; Air28: -2 %).

*Conclusions*

In the relatively large group of SCUBA divers, decompression free dives with either air or Air28 at agreeable conditions did not remarkably affect static or dynamic measures of pulmonary function. Limited usage of oxygen enriched air (Air28) in decompression free dives within maximum operating depths seems not to be associated with measurable, functional pulmonary changes. Repetitive usage over extended periods might provide different outcomes.

OP-12

**HEART RATE DURING RECREATIONAL SCUBA DIVING**

Brebeck A.[1], Muth T.[2], Koch A.[3], Kähler W.[3], Balestra C.[4], Deussen A.[1], Schipke J.[1]

[1] Institute of Physiology, Technical University Dresden, Germany
[2] Institue of Occupational Medicine and Social Medicine, Heinrich-Heine-University Düsseldorf, Germany
[3] German Naval Medical Institute, Kiel-Kronshagen, Germany
[4] Environmental & Occupational Physiology Laboratory, Haute Ecole Paul-Henri Spaak, 1160, Brussels, Belgium

Keywords: Recreational diving, Research

*Objectives*

Heart rate (HR) during SCUBA diving is modified by a couple of partially opposing factors. Sympathetic activity could be increased via physical and psychological stress. Fluid loss during the 60 min dive could equally increase HR. Immersion increases the intrathoracic blood volume and reduces HR. Similarly, submersion may decrease HR via the diving bradycardia as will do hyperoxia.

SCUBA dives were performed to test the following hypotheses: HR decreases during diving with compressed air / Nitrox. The decrease depends on breathing gas and diving experience but not on gender.

*Methods*

In a prospective, randomized study in the Red Sea (Subex, El Quesir, ET), HR was assessed in 108 (female: 38) volunteers during standardized dives. In each pair of divers one used air and the other Air28=Nitrox28 (blinded manner). The dive duration was divided in 10 equidistant periods, and HR was averaged within each of these.

*Results*

The 54 dives lasted on average 62±5 min (mean±SD) leading to a maximum depth of 24±1 m. HR for the entire cohort equalled 98±14 /min at dive begin and 79±10 /min at end of dive. The average HR decrease did neither depend on the breathing gas (air: 97±16 vs 80±12 /min; Air28: 100±12 vs 78±9 /min), nor on the diving experience nor on the gender (air: 98±14 vs 79±10 /min, Air28: 99±14 vs 81±10 /min).

*Conclusions*

During extended, calm dives with agreeable conditions HR decreased by about 20%. This decrease did not depend on breathing gases, diving experience or gender.

OP-13

## COGNITIVE PERFORMANCE DURING SCUBA DIVING USING $O_2$-ENRICHED AIR

Brebeck A.[1], Schmitz-Pfeiffer H.[2], Schipke J.[3]

[1] Institute of Physiology, Technical University Dresden, Germany
[2] Institute of Neurology, TU Dresden, Germany
[3] Research group Experimental Surgery, University Hospital Düsseldorf, Germany

Keywords: Nitrogen narcosis, Recreational diving, Research

*Objectives*

It was investigated, whether $O_2$-enriched breathing gases would modify memory and/or alertness during scuba diving.

*Methods*

In a prospective study, 108 (38 females) advanced divers performed in the Red Sea (Subex, El Quesir) a Visualized Learn and Memory Test (VLMT: short delay plus long delay) and 'Number Connecting Test' (NCT: 1-90) during standardised dives, lasting 62±5 min and leading to a maximum depth of 24±1 m. The blinded volunteers dived in pairs using either air or nitrox28 (=air28).

*Results*

Number of correctly remembered words for short delay (air: 7.4±1.9; air28: 7.9±2.0) and for long delay (air: 6.4±2.2; air28: 6.8±2.2) differed only slightly. Likewise, the duration to complete the NCT was not different (air: 87.1±30.3; air28: 84.7±26.7). If fouls in this test were taken in account, there was a tendency for better results with air28 ($p=0.068$). The number of remembered words and the duration to complete the NCT did neither depend on diving experience nor on age.

*Conclusions*

Reduction of the $N_2$-portion in the breathing mixture from 78 to 71 % seems not affect the cognitive performance in advanced divers in convenient waters. It is, however, remembered that enriching the breathing air with $O_2$ increases its toxic potential.

OP-14

## CARDIOVASCULAR AND RESPIRATORY RESPONSES TO APNEA IN UNTRAINED MALES AND BREATH-HOLD DIVERS

Narycheva I.[1], Kuznetsov S.[1], Rostovsky A.[1], Popov D.[1]

[1] SSC RF – Institute for Biomedical Problems RAS, Russian Federation

Keywords: Breath-hold diving, Research

*Objectives*

Aim of the present study was to investigate cardiovascular and respiratory responses to apnea in untrained males and breath-hold divers.

*Methods*

Twenty two volunteers: 9 healthy untrained males and 13 male breath-hold divers participated in the study. Breath-holding was performed at rest in air. Total and vital lung capacities were assessed. Blood pressure, heart rate, arterial blood oxygen saturation ($SO_2$) was measured continuously during apnea. Near infrared spectroscopy was used for measurement of tissue oxygenation index (TOI), change of oxy- and deoxyhemoglobin content in brain frontal lobe. The sum of these last two variables is change of total hemoglobin (Hb) content in the region of interest and reflected its blood filling. TOI is the ratio of oxyhemoglobin to Hb content in tissue. Partial pressure (PA) of $O_2$ and $CO_2$ in alveolar air was tested pre- and post-apnea and rates of apnea $V'O_2$ and $V'CO_2$ were calculated.

*Results*

The mean height of the subjects was (C-group 181 +/-1.9cm, D-group 175,6±1,4), and the mean weight was (C-group 76.8 +/- 3.7kg, D-group 78.3 +/- 2.9kg). Duration of apnea in C-group was significantly ($p<0.05$) shorter than in D-group, 176+/-19 s and 261+/-10 s accordingly. At the apnea breakpoint, PA $O_2$ and $SO_2$ (54+/-5.1 mm Hg and 88+/-2.5 %) in C-group were significantly ($p<0.05$ for both) higher than corresponding values in D-group (42+/-3 mm Hg and 80+/-2.0%). Inverse linear relationships between duration of apnea and both PA $O_2$ and $SO_2$ at apnea breakpoint were found in C-group ($r=-0.82$ and $-0.86$ correspondingly; $p<0.05$), whereas in D-group no relationships were observed. No significant correlations were found between apnea duration and PA $CO_2$ at apnea breakpoint for both groups. Moreover, mean PA $CO_2$ at apnea breakpoint was similar for untrained males and breath-hold divers (C-group 53.2+/1.6 mm Hg and D-group 53.5+/1.1 mm Hg, accordingly). In C-group apnea duration correlated with $V'CO_2$ ($r=-0.90$; $p<0.05$) and did not significantly correlated with $V'O_2$. On the contrary, there were no significant correlations in D-group between apnea duration and both $V'CO_2$ and $V'O_2$. In C-group correlations were found for apnea duration and changes of HR, Hb content and TOI during apnea ($r=-0.66$; $p<0.05$, $r=0.71$; $p<0.05$, $r= -0.83$; $p<0.05$). Such correlations were not found for D-group.

*Conclusions*

Thus, PA $CO_2$ in both groups at apnea breakpoint was similar. The longer breath hold duration in C-group was significantly associated with the lower $V'CO_2$. The correlations were found between apnea duration and changes in cardiovascular and respiratory parameters only in untrained males.

OP-15

## ECG AND EMG MEASUREMENTS DURING DIVING USING A PDA BASED DIVE COMPUTER: FIRST STEP INTO THE WEARABLE DIVE COMPUTER

Ozyigit T.[1], Memişoğlu M.[2], Egi M.[1]

[1] Computer Engineering Dept. Ciragan, University of Galatasaray, Turkey
[2] Bogazici Underwater Research Center, Turkey

Keywords: Commercial diving, Equipment, Recreational diving

*Objectives*

Diver carried decompression computers are aimed to provide safe ascent profiles based on depth and duration. Auxiliary parameters such as gas consumption, external temperature and heart rate are also measured and recorded. The aim of this study is to launch a research on the development of a wearable dive computer integrating all possible physiologic measurements meaningful for diving and hyperbaric activities. The first phase includes ECG and EMG.

*Methods*

Divephone PDA based dive computer system has been modified to accommodate Shimmer Wireless Sensor. A mobile phone (Samsung Omnia II) has been used to receive depth and temperature information from External Module of the Divephone through Wi-Fi (IEEE 802.11 b/g) while Shimmer Wireless Sensor communicates 2 channel ECG or EMG data through Bluetooth. The Shimmer Wireless Sensors has been used in a dry suit to provide ECG electrodes insulation from water. Adjustable strap is used to hold Shimmer Sensor and electrodes securely around diver's chest.

*Results*

The system has been used by two divers, in four SCUBA dives ranging from 8-21 meters to record dive profiles as well as EMG and ECG signals. The recorded ECG records were found to be adequate by a medical doctor. Signal deformation is observed while brusque movements like entry to water, exit or dry suit donation; however returning back to normal upon resuming normal fin kicking or walking activity.

*Conclusions*

The present Divephone decompression algorithms do not take into account the heart rate, ECG or EMG. Controlled experiments are needed to be designed to include such parameters in the decompression algorithm. The EMG data when used in combination with wearable accelerometers can also be used to test the fin kicking efficiency as well. This system is just the first step in development wearable computer for divers. It has been designed for future scalability and expansion in divers' and HBO patient's physiological parameters.

OP-16

**BIOPHYSICAL MODELS OF DECOMPRESSION: REVIEW AND PERSPECTIVES**

Hugon J.[1], Blatteau J.[2]
[1] BF SYSTEMES, France
[2] Institute of Military Biomedical Research (IRBA), France

Keywords: Decompression tables/algorithms/procedures, Modelling

*Objectives*

During a decompression, a part of the gas dissolved in the body is eliminated through bubbles, what generates potentially severe forms of decompression sickness (DCS). Known mathematical models allow the determination of safe decompression procedures for a limited range of exposures (pressure, duration, breathing gas). An extrapolation of these models to any type of exposition remains hazardous. It is deemed that only a biophysical approach of decompression can produce a relevant model for DCS prevention.

*Methods*

More than fifty key scientific publications and reports were analyzed. A critical review of the mathematical models developed so far is proposed. Biophysical criteria are defined to classify and assess these models according to their theoretical foundations, in particular concerning DCS mechanisms, gas exchanges, microbubbles formation, growth and transit in the body.

*Results*

It is demonstrated that neither the models having produced operational decompression tables nor other fundamental works are built from a sufficient biophysical basis. Moreover, most of them fail to explain the kinetics of bubbles production by the body and their prolonged transfer into the blood as pointed by numerous Doppler detection campaigns.

*Conclusions*

By merging the best of the different views, it seems nevertheless conceivable to build a relevant decompression model. A combination of tissular and vascular bubbles approaches appears necessary. The main characteristics of such model are proposed. Doppler detections data are pointed out as being essential to make both correlation and validation phases credible and to give confidence in such a biophysical model.

OP-17

## PHYSIOPATHOLOGY OF DECOMPRESSION, PHYPODE PROJECT

Guerrero F.[1], Kot J.[2], Marroni A.[3], Germonpré P.[4], Donda N.[5], Angelini S.[6], Dujic Z.[7], Sieber A.[8], Taher A.[9], Meintjes J.[10], Gardette B.[11], Pontier J.[12,] Théron M.[1], Garofalo G.[6], Distefano G.[6], Ljubkovic M.[7], Cronje F.[10], Sakr A.[9], Balestra C.[13]

[1] EA 4324 - ORPHY, University of Brest, France
[2] National Center for Hyperbaric Medicine, Medical University of Gdansk, Poland
[3] DAN Europe, Italy
[4] Hyperbaric Oxygen Center, Military Hospital Queen Astrid, Belgium
[5] G.T. Di Trampus Graziella, Italy
[6] Mares S.p.a., Italy
[7] Department of Physiology, University of Split School of Medicine, Croatia
[8] IMEGO, Sweden
[9] Hyperbaric Medical Center, Egypt
[10] Department Interdisciplinary Health Sciences, Stellenbosch University, Faculty of Health Sciences, South Africa
[11] COMEX S.A., France
[12] French Navy Diving School, French Navy, France
[13] Environmental & Occupational Physiology Department, ISEK - Haute Ecole Paul Henry Spaak, Belgium

Keywords: Projects, Research

*Objectives*

The PHYPODE project seeks to advance understanding of the decompression phenomena by uniting academic and industrial partners on an international scale to provide a collaborative training and research programme for Early Stage (ESR) and Experienced (ER) researchers.

*Methods*

More specifically, the PHYPODE project will:

- Develop an educational and research framework for the cross-fertilization of research activities concerning the physiopathology of decompression;
- Provide young researchers with the opportunity to: share research techniques and resources, benefit from the knowledge of international scientists in this field, take advantage of a program of research promoting strong interactions between industry, medical centres and academia, participate in international networking events concerning the domain, undertake secondments in industry/clinical and laboratory contexts;
- Widen the career prospects of researchers by enabling them to embrace the entire chain of research activities; from fundamental research for pathophysiological understanding of decompression, to applied research in industry for the management of decompression.

*Results*

To achieve this training & research programme, the academic partners, international not-for-profit associations, hyperbaric medical centres and industrial partners of the PHYPODE project have formed an international consortium.

The objectives of the consortium are underpinned by close collaboration between the members to leverage complementary expertise and construct a common program of education and research.

*Conclusions*

PHYPODE is funded by the European Community as a Marie Curie FP7-PEOPLE-2010-Initial Training Network program. It began in January 2011 and will finish in 4 years at the end of 2014.

OP-18

## SWEDISH POLICY FOR DIABETES AND RECREATIONAL DIVING

Örnhagen H.[1], Adolfsson P.[2], Jendle J.[3]

[1] Swedish Sportsdiving Federation, Sweden
[2] Department of Pediatrics, Institute of Clinical Sciences, Göteborg Pediatric Growth Research Center, Sweden
[3] Faculty of Health and Medicine, Endocrine and Diabetes Center, Karlstad Hospital, Sweden

Keywords: Complications, Recreational diving, Safety

*Objectives*

In Sweden, like many other countries, diabetes mellitus has been a contraindication for SCUBA diving. Based on data from Edge and co-workers together with Swedish research in the field, modified recommendations regarding diving and diabetes were issued in 2010.

New and more physiologic insulin treatments together with download of home glucose meters and the use of meters for continuous glucose monitoring (CGM) have made it possible to assure safe glucose levels during recreational diving.

*Methods*

Using CGMS™ (Medtronic), in a group of 12 divers with, and 12 without, insulin depending diabetes during a series of 5 dives in cold water during 3 days, made it possible to show that the fall of glucose during diving in divers with diabetes was not worse than it could be compensated for by an increase in plasma glucose levels before the dive through intake of approximately 20g (0.3g/kg body weight) of carbohydrates.

*Results*

The persons with diabetes who would like to become divers should be able to prove, through recorded glucose measurements, that they have a stable glucose level over time and HbA1c levels within the ideal range. All divers to be with diabetes should be registered and in contact with a designated doctor who is also responsible for the recommendations and advices regarding diving with diabetes. In case of uncertainty CGM recording during diving can be part of the investigation of a difficult case. CGM monitors and sensors have been pressure tested in chamber experiments and proven reliable. However, malfunctioning membrane buttons and liquid crystal displays make it impossible to adjust and calibrate the unit at pressure, which is not needed during use at pressure anyway.

*Conclusions*

Divers with diabetes type 2 should preferably be treated with Metformine in monotherapy or in combination with either DPP-4 inhibitors or GLP-1 analogues while Sulphonylureas and Glinides should be avoided due to the increased risk of hypoglycaemia with these agents.

OP-19

## PLATELET MICRO-PARTICLES AND BUBBLE FORMATION DURING DECOMPRESSION AFTER A PROVOCATIVE DIVE

Pontier J.[1], Gempp E.[2], Guerrero F.[3]

[1] Toulon, French Navy Diving School, France
[2] Toulon, Department of Hyperbaric and Diving Medicine, France
[3] EA 4324 - Laboratory ORPHY, University of Brest - Faculty of Sports Sciences, France

Keywords: Projects, Recreational diving, Research

*Objectives*

Previous studies highlighted a predominant involvement of platelet activation and thrombin generation in a rat model of decompression sickness (DCS). Endothelial cells and platelet shed micro-particles (MP) upon activation and during cell apoptosis. The aim was to study MP as a marker of bubble-induced platelet aggregation during decompression after a provocative dive.

*Methods*

Healthy experienced divers were assigned to one experimental group (n=10) with an open-sea air dive and one control group (n=5). Bubble grades were monitored with a pulsed doppler. Blood samples for endothelial MP (CD31), platelet MP (Annexin V and CD41), leucocyte MP (CD11b and CD66b) were taken 1-h before and after exposure in two groups.

*Results*

None of the divers developed any signs of DCS. The results showed a significant increase in platelet MP (with 2307 ng/µl +/- 471 vs 2005 ng/µl +/- 848 for Annexin V and 2245 ng/µl +/- 620 vs 2026 ng/µl +/- 821 for CD41) after diving with no change in control group. We found a significant correlation between the platelet MP values after decompression and the bubble grade ($R^2$=0.905, n=10, $p<0.05$). There was no significant change for CD31, CD11b and CD66b values.

*Conclusions*

The present study highlighted a relationship between platelet MP and bubble formation. Platelet MP has a pro-coagulant activity with thrombin generation and they involve in the vascular disorders. Platelet MP could play a key role in the pro-thrombotic event during decompression and the pathogenesis of DCS.

OP-20

## EFFECT OF OXYGEN BREATHING AND PERFLUOROCARBON EMULSION TREATMENT ON AIR BUBBLES IN ADIPOSE TISSUE DURING HYPOBARIC EXPOSURE AT 25 KPA

Randsøe T.[1], Hyldegaard O.[1]

[1] Department of Anaesthesia 4231, Rigshospitalet, Denmark

Keywords: Adjunctive treatment, Decompression tables/algorithms/procedures, Recreational diving

*Objectives*

In rats decompressed from a 1-hour hyperbaric air dive at 385 kPa to 101.3 kPa, extravascular micro air bubbles in adipose tissue shrink and disappear faster during combined normobaric oxygen breathing and PFC infusion, as compared to oxygen breathing alone. However, when similar micro air bubbles are studied at 25 kPa (~10.350 meters above sea-level), bubbles grew and stabilized despite continued oxygen breathing. The purpose of this experiment was to study the effect of combined oxygen breathing and PFC infusion on extravascular bubbles in adipose tissue of anesthetized rats decompressed and held at 25 kPa.

*Methods*

Micro air bubbles were injected into the exposed rat adipose tissue at 101.3 kPa and bubble area measurements at 101.3 and 25 kPa was conducted. Rats were administered PFC (N=10) prior to decompression and breathed 100% oxygen during the entire experiment. In the control group (N=8) from a previous report (1) rats were breathing oxygen alone at 25 kPa. Bubbles were studied at altitude for 215 min.

*Results*

Preliminary results show that at 25 kPa, all bubbles in the PFC group initially grew followed by a stabilization phase after which most bubbles would start to shrink. This was no different from bubbles in the control group (1).

*Conclusions*

The results indicate that the beneficial effect of combined oxygen breathing and PFC infusion on bubble resolution at sea level is neutralized at a barometric pressure of 25 kPa, due to an increased contribution of metabolic gases and water vapour to bubble volume.

1: Randsøe T, Hyldegaard O. J Appl Physiol;107(6).1857-63, 2009.

OP-21

**BENEFICE OF OXYGEN BREATHING VERSUS PRESSURE ON BUBBLE REDUCTION FOR OPTIMIZING DECOMPRESSION PROCEDURE**

Blatteau J.[1], Hugon J.[2], Gempp E.[3], Peny C.[4], Vallee N.[1]

[1] ERRSO TOULON - IRBA, France
[2] BF SYSTEMES, France
[3] SMHEP - HIA STE ANNE TOULON, France
[4] CEPHISMER ALFAN TOULON, France

Keywords: Decompression tables/algorithms/procedures, Deep diving, Research

*Objectives*

The aim of this study was to get more clear information about the effects of different experimental ascent profiles (EAP) on bubble reduction, using pure oxygen or a brief recompression during decompression.

*Methods*

4 EAP were evaluated in a group of 8 military divers using Nitrox 40% $O_2$ breathing with a rebreather. For EAP 1 and 2, 100% $O_2$ was used for the end stage of decompression, with 30% reduction of decompression time in EAP 1 and 50% in EAP 2. For EAP 3 and 4, Nitrox 40% $O_2$ was maintained during all the decompression stage. EAP 3 is based on a standard profile of deco stops whereas EAP 4 involved a brief period of recompression at the end of the stop.

*Results*

EAP 1 significantly reduced bubble formation whereas high bubble grades occurred with others EAP. We found no statistical differences in bubbles scores between EAP 3 and 4. One diver developed mild neurologic symptoms after EAP 3.

*Conclusions*

The most efficient preventive measure for reducing bubble formation using rebreather involve pure oxygen breathing with 30% reduction of decompression time compared with the corresponding air schedule. This effect was more beneficial than a brief recompression at the end of the decompression stop.

OP-22

**PROTEIN EXPRESSION PROFILES IN BRAIN AND PROTEIN S100B IN SERUM FOLLOWING HELIOX SATURATION DECOMPRESSION IN RATS**

Hope A.[1], Havnes M.[2], Bjørkum A.[3], Stuhr L.[4], Grønning M.[4]

[1] NUI AS, Norway
[2] Norwegian University of Science and Technology , Norway
[3] Bergen University College, Norway
[4] University of Bergen, Norway

Keywords: Long-term effects, Research, Saturation diving

*Objectives*

A rat model resulting in neurological symptoms of decompression sickness (DCS) after heliox saturation decompression has been established. This model will be used in experiments designed to get information about mechanisms involved in the etiology of DCS. The main objective of the present study was to determine effects of decompression, with and without DCS symptoms, on brain protein expression profiles and serum protein S100B.

*Methods*

Two groups of rats were trained to walk on a treadmill for determination of DCS symptoms. The animals were pressurized with heliox to 5 bar with $pO_2$ = 50 kPa at final pressure. After 3 hours at 5 bar the rats were decompressed at rates of 1 bar/20 s and 1 bar/10 min. Protein expression profiles in brain tissue samples are presently being analysed using standard proteomics methods. S100B were analysed in serum sampled about one week before the dive, two hours after the dive and one week after the dive.

*Results*

Symptoms of DCS were observed in about 50% of the animals as assessed on the treadmill shortly after decompression. No differences in S100B were observed when comparing the different sampling times. Results from the ongoing protein expression analysis will be presented.

*Conclusions*

Despite massive DCS symptoms no changes in S100B were observed. This is in contrast to findings in a comparable rat study with air where we observed a correlation between bubble grades and S100B levels. Differences in the volume reduction rate of helium and nitrogen gas bubbles after decompression may explain the discrepant findings.

OP-23

## PHYSIOLOGICAL EFFECTS OF RAPID REDUCTION IN CARBON DIOXIDE PARTIAL PRESSURE IN SUBMARINE TOWER ESCAPE

Loveman G.[1], Seddon F.[1], Thacker J.[1], White G.[1], Jurd K.[1]

[1] Maritime Life Support, QinetiQ Ltd, United Kingdom

Keywords: Research

*Objectives*

The NATO Submarine Rescue Manual states: “The change from a contaminated submarine atmosphere, especially if the carbon dioxide level is high (> 3%) to a clean atmosphere can lead to sudden collapse.” The origin of this statement is unclear. The objective of this trial was to determine whether adverse effects from a rapid drop in carbon dioxide partial pressure ($PCO_2$) in the breathing gas could hinder or prevent submarine tower escape.

*Methods*

A total of 34 male volunteers, mean (SD) age 33.8 (7.5) years, completed the trial. They breathed air for five minutes then 5% $CO_2$/16% $O_2$ (balance $N_2$) for one hour before switching to breathing 100% $O_2$ for 15 minutes and then returned to air breathing. Breathing gases were supplied from cylinders via SCUBA regulators and mouthpieces. Blood pressure, cerebral blood velocity, electrocardiogram and end-tidal $PCO_2$ and $PO_2$ were monitored throughout. Subjects were asked at intervals to indicate symptom type and severity.

*Results*

Symptoms whilst breathing 5% $CO_2$/16% $O_2$ included breathlessness and headache. Following the switch to 100% $O_2$ seven subjects reported mild to moderate faintness, which was associated with a significant drop in cerebral blood flow compared to those that did not feel faint ($P<0.02$). No subject vomited or fainted following the switch from breathing 5% $CO_2$/16% $O_2$ to breathing 100% $O_2$.

*Conclusions*

Fainting, sudden collapse or vomiting are unlikely to occur on switching to 100% oxygen following acute exposures to hypercapnia at a $PCO_2$ of up to 5.0 kPa.

OP-24

## SENSORIZED REBREATHER MOUTHPIECE WITH INTEGRATED $O_2$ AND $CO_2$ SENSORS

Sieber A.[1], Krozer A.[1]

[1] IMEGO AB, Sweden

Keywords: Commercial diving, Recreational diving, Scientific diving

*Objectives*

Assessment of $PO_2$ and $PCO_2$ is of major interest in closed circuit rebreathers diving. State of the art in CCRs is using multiple galvanic $O_2$ sensors and for $CO_2$ either direct, infrared based methods or indirect, scrubber temperature based approaches. Conventional $PO_2$ sensors are rather slow (t90>6s), are failure prone and have a short lifetime. Optical $PCO_2$ sensors are used in just two commercial available rebreathers.

*Methods*

At EUBS 2010 we presented our investigations on ceramic solid state microsensors for rebreathers in terms of measurement range and resolution. A miniaturized sensor module was now developed comprising one $PO_2$ and one $PCO_2$ sensor and a control/measurement electronics. Due to the small size, it can be fitted between the mushroom valves of a rebreathers mouthpiece. The sensor module is connected to an external battery pack. Via a USB interface data can be transmitted to a PC. A graphical user interface for data visualization and storage was developed under LabView.

*Results*

One prototype of a sensorized mouthpiece was developed. Fast response times of less than 120ms allow detailed $PO_2$ and $PCO_2$ measurement in inhaled and exhaled gases.

*Conclusions*

Solid state $PO_2$ and $PCO_2$ sensors were mounted directly in a rebreather mouthpiece. In this position $EtCO_2$ can be measured and even failure detection of the mushroom valves is possible. Disadvantage of these sensors is the large power consumption of about 1.8W per sensor. Due to the small size of the sensors, also an integration of the $CO_2$ sensors in conventional open circuit second stages is possible, which could be used as alarming device.

OP-25

**MECHANISMS OF NITRIC OXIDE-DEPENDENT HYPEROXIC VASOCONSTRICTION**

Demchenko I.[1], Allen B.[1], Piantadosi C.[2]

[1] Anesthesiology, Duke University, United States
[2] Medicine, Duke University, United States

Keywords: Oxidative stress, Research

*Objectives*

Hyperoxia interferes with basal vascular tone by decreasing the bioavailability of nitric oxide (NO). The resulting vasoconstriction is only partly due to decreased activation of soluble guanylate cyclase. We hypothesize that hyperoxic vasoconstriction results from at least two other factors: increased production of endothelin (ET-1) and sympathetic activation. We evaluated effects of NO, EN-1 and sympathetic activity on cerebrovascular responses in normoxia and hyperoxia.

*Methods*

Microdialysis was used to deliver NOS inhibitors (L-NAME, 3-Br-7-NI), the NO donor SNAP, ET-1, the ET-1A receptor blocker (BQ-123), or adrenergic agonist/antagonists to rat striatum. Cerebral blood flow (CBF) near the microdialysis probe was measured by hydrogen clearance in four experimental conditions: normoxic breathing, local cerebral hyperoxia (induced by perfusing the microdialysis probe with $O_2$-saturated artificial CSF), and alveolar hyperoxia at 1 and 3 ATA $O_2$. We also assessed central hemodynamics and sympathetic activity at 1 or 3 ATA $O_2$ after NOS inhibition or baroreceptor denervation.

*Results*

In striatal hyperoxia, we observed the following local effects: decreased NO bioavailability, vasoconstriction, and increased ET-1 release. In animals breathing $O_2$ at 1 or 3 ATA, we observed augmented sympathetic outflow. In 3 ATA $O_2$, vasoconstriction and sympathetic outflow increased further after baroreceptor denervation.

*Conclusions*

Our novel findings are that hyperoxic vasoconstriction resulting from decreased NO bioavailability is potentiated by increases in ET-1 production and sympathetic outflow. ET-1 rises because NO normally restrains ET-1 production, and the role of sympathetic outflow is clearly demonstrated by the fact that vasoconstriction is exacerbated when baroreceptor reflexes are suppressed.

OP-26

## THE EFFECTS OF THE HYPERBARIC OXYGENATION ON ANTIOXIDANT STATUS AND LIPID PEROXIDATION AFTER THE EXPERIMENTAL BRAIN INJURY

Brkic P.[1], Jovanovic T.[2], Krstic D.[3], Pekovic S.[4], Colovic M.[5], Mitrovic A.[1], Lavrnja I.[4], Dacic S.[4], Bjelobaba I.[4], Stojkov D.[4], Parabucki A.[4], Jovanovic T.[2]

[1] Institute of Medical Physiology, School of Medicine, University of Belgrade, Serbia and Montenegro
[2] Centre for Hyperbaric Medicine Belgrade, Serbia and Montenegro
[3] Institute of Medical Chemistry, School of Medicine, University of Belgrade, Serbia and Montenegro
[4] Department of Neurobiology, Institute for Biological Research Sinisa Stankovic, Serbia and Montenegro
[5] Institute of Nuclear Sciences Vinca, University of Belgrade, Serbia and Montenegro

Keywords: Oxidative stress, Research

*Objectives*

It has been proposed that hyperbaric oxygenation (HBO) may have positive effects on the neural survival after the brain injury, but the mechanisms involved in this activity are still vague. To investigate the effects of HBO after suction ablation of sensory - motor cortex on oxidative status.

*Methods*

The experiments were conducted on the male Wister rats, 10 weeks old. Animals were divided in the following groups: Control (C, n = 8) intact animals, Control + HBO (CH, n = 8) intact animals that were subjected to HBO treatment, Sham control (S, n = 8) animals that underwent surgical procedure without damaging the brain tissue, Sham control + HBO (S, n = 8), Lesion group (L, n = 8) right sensory - motor cortex was surgically removed, Lesion + HBO (LH, n = 8). HBO protocol: pressure applied 2.5 ATA, for 60 minutes, once a day for 10 days. Malondialdehyde (MDA) content, activity of superoxide dismutase (SOD) and glutathione peroxidase (GSH-px) sampled from hemi cortex were measured. Our research was approved by the Ethical Committee of the School of Medicine, University of Belgrade.

*Results*

Significantly reduced level of MDA was found in LH group compared to L group ($p < 0.05$). Activity of SOD and GSH-px were significantly increased in LH group compared to L group ($p < 0.05$).

*Conclusions*

Our data indicate that HBO therapy inhibits the lipid peroxidation and intensify the antioxidant activity of SOD and GSP-px after experimental brain injury.

OP-27

## EFFECTS OF HBOT ON SURVIVAL AND DIFFERENTIATION OF NEUROECTODERMAL CELLS WITH STEM CELL PROPERTIES IN CORTICAL INJURY MODEL

Agoston V.[1], Zadori A.[2], Demeter K.[2], Hadinger N.[2], Varady L.[2], Kohidi T.[2], Göbl A.[1], Nagy Z.[3], Madarasz E.[4]

[1] Hyperbar Centre Budapest, Baromedical PLc, Hungary
[2] Hungarian Academy of Sciences, Budapest, Laboratory of Cellular and Developmental Neurobiology, Institute of Experimental Medicine, Hungary
[3] Department Section of Vascular Neurology, Semmelweis University, Budapest, Hungary
[4] Hungarian Academy of Sciences, Budapest, Laboratory of Cellular and Developmental Neurobiology, Institute of Experimental Medicine, Hungary

Keywords: Research

*Objectives*

The freeze-lesion cortical injury provides permissive environment for long-term survival and repopulation of non- differentiated implanted neural progenitors, but does not support their neuron formation. Hypoxia, among numerous factors, is suspected to impair neuronal cell fate commitment.

*Methods*

The consequences of HBOT were studied in vivo, on cold lesioned host mice implanted with GFP-4C neuroectodermal stem cells. The animals were subjected daily to a 90 min hyperbaric oxygen treatment (2.5 ATA, 100% $O_2$ for 2x30 min) for 7 consecutive days starting from D7 (e.g., the 7th post-lesion day corresponding to the 1st post-implantation day). In total, 37 adult animals were treated with HBOT. Three normoxic and three hyperbaric groups of animals were divided into subgroups: cryogenic lesioned, stem cell implanted into intact cortex, and stem cell implanted into lesioned cortex. The total number of animals was 84.

*Results*

In vivo, neural stem/progenitor cells survived and proliferated in freeze-lesioned adult mouse forebrains, sporadically differentiated into astrocytes but did not develop into neurons. Hypoperfusion-caused hypoxia in lesioned cortices was partially corrected by hyperbaric oxygen treatment (HBOT). HBOT, while reduced the rate of cell proliferation at the lesion site, resulted in sporadic neuron formation from implanted neural stem cells. The data indicate that in hypoxic brain areas, neural stem cells survive and proliferate, but neural tissue-type differentiation can not proceed.

*Conclusions*

Oxygenation renders the damaged brain areas more permissive for tissue-type differentiation and may help the integration of neural stem/progenitor cells. The mechanism for HBO-induced brain protection includes tissue oxygen delivery increase, especially to areas of diminished flow, thus enhancing neuronal viability, reduction of brain edema, and improvement of postischemia metabolism. However, the effect of oxygen treatment on survival and differentation of implanted neuroectodermal cells needs to be further clarified.

OP-28

**USEFULLNESS OF HYPERBARIC OXYGEN IN THE TREATMENT OF ACUTE ACOUSTIC TRAUMA**

Przewoźny T.[1], Kot J.[2], Narożny W.[1]

[1] ENT Department, Medical University of Gdańsk, Polska
[2] National Center for Hyperbaric Medicine in Gdynia, Medical University of Gdańsk, Polska

Keywords: Adjunctive treatment, Indications

*Objectives*

Acute acoustic trauma (AAT) is an effect of single exposition to noise with very high level of acoustic pressure on auditory organ. Clinically it is characterized by sensorineural hearing loss in high tones (3-4 kHz), tinnitus, earache and vertigo. There are a lot of therapeutic methods in the treatment AAT: observation, vasodilators, steroids administer both systemic and intratympanic and also hyperbaric oxygen therapy (HBO). We have investigated the combined effect of hyperbaric oxygen therapy (HBO) and pharmacological treatment (vasodilators, glucocorticoids and vitamins) to patients with AAT and compared it to effect of pharmacological treatment only (vasodilators, glucocorticoids and vitamins).

*Aim*
The investigation of audiometric data from patients treated for AAT by HBO.

*Methods*

The material consisted of 21 patients with defined AAT treated simultaneously in the ENT Department and National Center for Hyperbaric Medicine of the Medical University of Gdańsk, Poland from 2006 to 2010 – group A. The HBO treatment consisted of exposures to 100% oxygen at pressure of 250 kPa for a total of 60 minutes in multiplace hyperbaric chamber from 5 to 20 expositions. The control group stated also 21 patients with AAT treated in the ENT Department Medical University of Gdańsk from 2006 to 2010 – group B. The treatment results (hearing gain) were estimated using pure-tone audiometry. We retrospectively analyzed the audiograms of all patients. We analyzed initial hearing loss and hearing gain in pure frequencies (0.5, 1, 2, 3, 4, 6, 8 kHz) and groups of frequencies: PTA (0.5, 1, 2 kHz), HTA (4, 6, 8 kHz), OAA (0.5, 1, 2, 4, 6, 8 kHz), and PMTA (0.5, 1, 2, 4 kHz).

*Results*

We observed greater hearing gain in patients from group A (HBO, vasodilators, glucocorticoids and vitamins) especially for single frequencies 2 and 3 kHz (improvement better respectively 7,9 and 9 dBHL) and for groups of frequencies (improvement better of 6 to 7 dBHL for PMTA and PTA) compared with those from group B (vasodilators, glucocorticoids and vitamins). The differences were estimated using Mann-Whitney test. Statistical significance was obtained for 0.5 kHz and PTA ($p<0.05$).

*Conclusions*

We concluded that HBO improves the results of the conventional AAT treatment and should be recommended. Additionally the best results are achieved if the treatment is started as early as possible.

OP-29

**RETROSPECTIVE ANALYSIS OF 101 SUDDEN DEAFNESS CASES TREATED WITH HYPERBARIC OXYGEN IN 2010**

Caers D.[1], Lafère P.[1], Vanhoutte D.[1], Germonpré P.[1]

[1] Centre for Hyperbaric Oxygen Therapy, Military Hospital Brussels, Belgium

Keywords: Adjunctive treatment, Indications

*Objectives*

We retrospectively analysed all patients treated at our facility with hyperbaric oxygen therapy (HBO) for idiopathic sudden sensorineural hearing loss (ISSHL) in 2010.

*Methods*

All patient records were reviewed and demographic and treatment data were correlated with improvement or stationary hearing. HBO was given at 2.5 ATA for 70 minutes (without air breaks) in a hospital-based multiplace pressure chamber. Pure tone audiometry was performed before the first HBO session and after 10 sessions, in the same circumstances. Thereafter, HBO was continued in case of improvement, and audiometry was repeated after each 5 HBO sessions until no further improvement. Hearing was evaluated using MHL (Mean Hearing Loss: average of 7 frequencies: 250, 500, 1000, 2000, 4000, 6000, 8000 Hz). A Mean Hearing Gain (MHG) of 10dB was taken as cut-off value for improvement.

*Results*

In total, 126 patients were referred for ISSHL. 25 patients were excluded from analysis: 5 who did not comply with treatment strategy in our centre (completion of a full course of high-dose corticosteroids prior to HBO), 4 because of a clear causative diagnosis and 16 who completed less than 6 HBO sessions. This leaves 101 patients (103 ears) in the analysis: 56 males and 45 females, of a mean age of 49 ± 15.8 years old. The average initial MHL was 54 ±26.8 dB. The average delay to HBO was 26 ± 14 days. The average number of HBO treatments was 12.4 ± 3.7. The incidence of mild middle ear barotrauma was 15.5%.

Globally, 23 patients had a MHG of more than 10dB (22.3%), of which 9 (8.7%) more than 30 dB. There was no statistically significant association between age, sex, smoking, type or severity of hearing loss and improvement after HBO.

There was a significant correlation between time to HBO and improvement. Only 5.5% of patients who started HBO more than 28 days after ISSHL, showed improvement, vs. 30.9% (21/68) of those that started HBO before 28 days. In those patients where HBO treatment started before 14 days, 52.4% (11/21) showed improvement.

*Conclusions*

In an unselected group of patients refractory to medical therapy, HBO improved hearing in 22.3%. As the median number of frequencies affected was 3, a MHG of 10 dB represents in most cases a clinically significant improvement. Treatment with HBO within 14 days was significantly more effective than HBO after a delay of longer than 28 days.

OP-30

## TREATMENT OF COMPLICATIONS IN CARDIAC SURGERY WOUND HEALING WITH THE HYPERBARIC OXYGEN THERAPY

Siondalski P.[1], Jaworski L.[1], Kołaczkowska M.[1], Kot J.[2]

[1] Cardiac Surgery Department, Medical University of Gdańsk, Poland
[2] National Center for Hyperbaric Medicine in Gdynia, Medical University of Gdańsk, Poland

Keywords: Adjunctive treatment, Indications

*Objectives*

Complications in cardiac surgery wound healing occur with the rate of 1-5% and pose serious risk to life and health of patients. In our study the use of hyperbaric oxygen therapy (HBOT) as an adjunctive treatment in cardiac surgery wound healing has been evaluated.

*Methods*

In the years 1997 – 2005, there were 12,309 patients operated with cardiac surgery. 147 patients (1.2%) had complications of post-sternotomy wound healing, including 51 patients with dehiscence with no signs of inflammation (Group 1), 38 patients with superficial wound infection (Group 2), 38 patients with acute (Group 3A) and 19 patients with chronic (Group 3B) deep infection of the wound and mediastinum. All patients were treated by: 1) antibiotic therapy based on microbiological evaluation and local wound treatment (opening, debridement and antiseptic dressing), 2) HBOT – about 10 sessions of 60 minutes breathing 100% oxygen at 2.5 ATA in a multiplace chamber (if there was no contraindication), 3) re-evaluation of wound healing and, as depending on the local status, continuation of HBOT with supportive therapy or surgical intervention.

*Results*

HBOT was used in 117 patients (80%). There were 5 to 55 sessions conducted with the average number of 20 sessions. In the rest of patients (30 cases; 20%) the HBOT has been contraindicated for different reasons, mostly cardiovascular instability and/or pulmonary restrictions. The re-operation was needed in 0.0%, 21.0%, 47% and 95.0% of cases in groups 1, 2, 3A and 3B, respectively. The mortality was 3.4% (5 cases), including one case (0.9%) in the group of patients treated with HBOT and 4 cases (13.3%) in the group of patients where there was no possibility to use HBOT. In statistical analysis, use of HBOT was an independent, statistically significant factor that reduced the risk of death with odd ratio (OR) of 0.04 (95% CI 0.005 – 0.3; p=0.002).

*Conclusions*

The HBOT used as adjunctive therapy should be recommended in treatment of complications in cardiac surgery wound healing. Use of multi-modal therapy, including HBOT, improves treatment results, as in 53% of patients in the Group 3A, the re-operation was not needed for complete recovery, although literature sources suggest that it is necessary in all such patients.

OP-31

## EXPERIENCES WITH ADJUVANT HBO THERAPY FOR SURGICALLY TREATED FRACTURES OF THE CALCANEUS

Hasmiller K.[1], Gabel J.[2], Buettner J.[1]

[1] Department of Anaesthesiology, BG-Unfallklinik Murnau, Germany
[2] Department of Traumatology, BG-Unfallklinik Murnau, Germany

Keywords: Data collection/analysis, Indications

*Objectives*

Calcaneal fractures are the most common fractures of the hindfoot. They are difficult to treat and often have poor outcome. Typical trauma via axial compression causes predominantly comminuted and impacted fractures with involvement of the articular surfaces due to the high ratio of articular surfaces and spongiose internal structure. Surgery with open reduction and internal fixation with plates is necessary for good recovery of anatomy and function.

But spare and compromised soft tissues often lead to necrosis of the skin and also deep soft tissue and bone infections. A special concept including an additional HBOT for soft tissue conditioning was developed in Murnau to prevent these complications.

Our first results concerning surgery of fractures of the calcaneus with concomitant HBOT in the period from May 2001 to May 2004 (presented in Ajaccio 2004) seemed to be successfully.

But there were still remaining questions. Unfortunately a randomized trial with control group without HBOT was refused.

*Methods*

We retrospectively analyzed our electronically recorded data for another 5 years starting from 2006. We compared calcaneal fractures which underwent surgery and HBOT (130 feet) with fractures which did not received HBOT due to contraindications, refusing by patient or other problems (36 feet).

*Results*

Most patients required surgery with plate osteosynthesis for severe fractures. Only 5 fractures were treated conservatively. There was a better outcome with fewer complications in the HBO group.

*Conclusions*

An additional HBOT appears to be advantageous to prevent wound healing disorders. But still further investigations with more patients are needed to validate this statement.

OP-32

## RISK FACTORS ASSOCIATED WITH THE DEVELOPMENT OF OSTEORADIONECROSIS FOLLOWING EXODONTIA IN IRRADIATED AREAS

Pepper J.[1], Gaffney C.[2], Oliver S.[3], Cronin A.[4], Bryson P.[1]

[1] Hyperbaric Medical Centre, Diving Diseases Research Centre, United Kingdom
[2] Department of Oncology, Velindre Hospital, United Kingdom
[3] School of Dentistry, Cardiff University, United Kingdom
[4] Department of Oral and Maxillofacial Surgery, Cardiff University, United Kingdom

Keywords: Research

*Objectives*

To perform a retrospective analysis of patients referred for hyperbaric oxygen therapy to treat osteoradionecrosis (ORN) associated with exodontia in irradiated fields, in order to determine risk factors and thus potential methods of prevention.

*Methods*

Data was collected from 51 patients referred for hyperbaric oxygen therapy to treat ORN related to exodontia in irradiated areas. Data collected included gender, age, medical history, smoking and alcohol status, Body Mass Index (BMI), and details of their cancer, cancer treatment, extractions and of their ORN.

*Results*

Smoking and alcohol usage, previous advanced-stage tumours, time elapsed since radiotherapy, being immunocompromised, and mandibular extractions were all associated with the development of ORN. 50.0% of the patients had received a total radiation dose of or lower than the 55 Gy threshold which is generally considered to be required for ORN to occur. Many extractions were performed by general dental practitioners.

*Conclusions*

The authors recommend that general dental practitioners routinely enquire about patients' radiation history and that they refer irradiated head and neck patients to maxillofacial departments for extractions. Prior to extraction of teeth in irradiated patients, information should be sought regarding the risk of ORN. The risk of developing ORN cannot be determined by total radiotherapy dose alone. Prior to exodontia in an irradiated field, due consideration should be given to prescribing pre- and post-operative hyperbaric oxygen therapy.

OP-33

## HYPERBARIC OXYGEN THERAPY FOR SCLERODERMA SYSTEMICA

Polyakova L.[1], Voronenkova E.[2], Kuzovkina A.[3], Apanasenko T.[4]

[1] HBOT Department of the First University Clinic, 1st Moscow State Medical University I.M.Sechenov, Russian Federation
[2] Rheumatology, 1st Moscow State Medical University I.M.Sechenov, Russian Federation
[3] Ultrasonic Diagnostics, 1st Moscow State Medical University I.M.Sechenov, Russian Federation
[4] Functional Diagnostics, 1st Moscow State Medical University I.M.Sechenov, Russian Federation

Keywords: Data collection/analysis, Indications, Long-term effects

*Objectives*

Scleroderma systemica (SS) is an autoimmune disease of connective tissue. Disorders of microcirculation, inflammation, generalized fibrosis and hypoxia form the basis for this chronic disease. For the first time HBO was used for therapy of systemic sclerosis by the specialists of Sechenov Medical Institute. The author's certificate for the invention was registered in 1982. More than 500 SS patients have been treated. The problem was to find optimal medical complex and HBO regimen for such patients.

*Methods*

54 patients have been observed since 2002. The most frequent signs were: skin lesions, articular alterations, Raynaud's syndrom (100%), pneumofibrosis (95%), cardiac injuries (81%), trophic disturbances and Sjogren's syndrom (60%). Medication included methylprednisolone, meloxicam, D-penicillamine, vasaprostan, lidaza. The patients have received from 1 till 17 courses of HBOT. Every course consisted of 10 procedures. HBOT was given every 6-10 months in monoplace oxygen chambers “Khrunichev BLKS”. The oxygen pressure inside the chamber was 1.3-1.5 ATA. The isopression continued 30-40 minutes. 16 patients have received 1-3 courses of active hyperemia of extremities. Clinical signs, laboratory findings, microcirculation, arterial wall resistance, severity index (E.Medsger), activity index DAS28, modified skin score (G.Rodnan) were regulated.

*Results*

The evident improvement was recorded. Sclerodermatous edema, trophic disturbances, interstitial pneumofibrosis and pulmonary hypertension, Raynaud's phenomenon, dysphagy, rhythm disturbances decreased. Lung capacity and joint range of motions increased. Esophageal motility became more intensive. The capillary circulation reserve tended to normalization. Microcirculation value improved ($p<0.001$). Decreasing of skin score, severity and activity indexes progressed gradually and had reached reliability ($p<0.001$) after three-year observation. The treatment efficacy estimated by DAS28 had shown “no effect” after the first year, “satisfactory” - after two years, “good” - only after three years.

*Conclusions*

The cure including medication, repeated HBOT courses and active hyperemia may be considered as an effective and perspective complex for SS. It may help to reduce the acute attack activity, to prolong remission, to maintain functional abilities, to facilitate social adaptation, to improve quality of life of patients.

OP-34

## HYPERBARIC OXYGENATION AS AN ADJUVANT THERAPY FOR THE DIABETIC FOOT

Jovanovic T.[1], Omerovic I.[1], Brkic P.[2], Mitrovic A.[2]

[1] Centre for Hyperbaric Medicine Belgrade, Serbia and Montenegro
[2] Institute of Medical Physiology, School of Medicine, University of Belgrade, Serbia and Montenegro

Keywords: Adjunctive treatment, Data collection/analysis, Wound care

*Objectives*

Chronic diabetic foot syndrome is a source of major concern for both patients and health care systems. The aim of this study was to evaluate whether hyperbaric oxygen can improve the outcome of the diabetic foot syndrome.

*Methods*

During the year of 2010 a total of 69 patients (age 57 ± 8 years, 56 male, 13 female) with diabetic foot were referred to the Center for hyperbaric medicine. All patients were given 100% molecular oxygen at 2.5 absolute atmospheres (ATA) for 90 minutes, five times a week for total of 25 sessions. During the treatment patients continued with theirs medicament therapy, ongoing wound care, oxygenation monitoring of lower limbs and artheriography was performed at the beginning and at the end of the treatment. Our research was approved by the Ethical Committee of the School of Medicine, University of Belgrade.

*Results*

Significant restitution of the functions and good healing of the ulcers was achieved in 42 patients. Eighteen patients had to continue HBO treatment for an average of 15 more sessions, until good wound healing. Five patients had to undergo toe amputation. For four patients, it was decided by the vascular surgeon that partial foot amputation (distal to the metatarsophalangeal joint) had to be performed. 86.8% of the patients preserved theirs feet. Their quality of life and social functioning were significantly improved.

*Conclusions*

If applied on time hyperbaric oxygen therapy facilitates healing of the diabetic foot ulcers and decreases the risk of lower extremity amputations.

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# Poster presentations

PP-01

## CAUSES OF DEATH AND CANCER INCIDENCE AMONG OCCUPATIONAL DIVERS IN NORWAY

Irgens A.[1], Troland K.[1], Thorsen E.[2], Grønning M.[1]

[1] Department of Occupational Medicine, Haukeland University Hospital, Norway
[2] Internal Medicine, University of Bergen, Norway

Keywords: Data collection/analysis, Long-term effects, Research

*Objectives*
Assess causes of death and cancer risk and among Norwegian occupational divers.

*Methods*

The Norwegian Labour Inspection Authority has registered all citizens with an occupational diving certificate. By August 2010 the Registry included 5.526 men born 1950-90. They were linked to the Norwegian Cause of Death Registry and Cancer Registry. The rest of the male population born in the same period (N = 1.617.660) constituted the reference group.

*Results*

Mortality among divers was 1.5% compared with 2.5% for the references; OR 0.60 (0.48-0.74). Focusing on cause of deaths, violent death was registered in 53 divers (64.6%), and 18.484 (46.9%) references; OR 2.11 (1.32-3.37). Each sub groups of violent death were compared to non-violent deaths. Nineteen divers (39.6%) and 6.464 (23.6%) references committed suicide, OR 2.28 (1.25-4.15). Thirty four divers (54.0%) and 11.288 (35.0%) references died in accidents; OR 2.17 (1.30-3.62) of which 12 divers (29.3%) and 6.342 (23.3%) references died in transport accidents; OR 1.41 (0.71-2.80). The causes of non-violent deaths were lower in divers. Twelve divers died of cancer (41.4%) and 6.114 (29.2%) references; OR 1.69 (0.71-3.55). The incidence of cancer was not increased among divers.

*Conclusions*

The lower overall mortality among divers was as expected since divers are a selected group of healthy subjects. The increased risks of suicide and violent deaths are of particular concern.

PP-02

**TREATMENT OF DECOMPRESSION INJURY IN CHILDREN, A SYSTEM FOR THE PATIENT AND THE PARENT**

Sifakis M.[1], Jansen E.[1]

[1] Department of Anaesthesia 4231, Rigshospitalet, Denmark

Keywords: Decompression tables/algorithms/procedures, Equipment, Recreational diving

*Objectives*

Still more children are SCUBA diving. The trend is international. Although some organisations provide advice and regulations intending to reduce risks of decompressions injury and gas embolism measures should be taken provide proper treatment. In treating children in a hyperbaric chamber it is essential to provide a relaxed situation and make it possible for a parent or another well known person to accompany the patient throughout the treatment.

*Methods*

The patient will breathe the oxygen or air through a translucent hood. The administered gas will be directed through a simple stopcock outside the chamber. Thereby the patient dos not need to be disturbed for other reasons than the neurologic testing by the staff. Normal tables for treatment are used. The accompanying parent or person is preferably also breathing in a translucent hood. If a table 6 is used the person is breathing NitrOx 50% untill ascent from 9 meters, then is shifted into pure oxygen breathing. If NitrOx is not available the person will be given the same gas as the patient in the last 3 oxygen periods on 9 meter and during the final decompression

*Results*

So far no child has been treated for diving injury in our unit. However the system has been used several times on other indications and shorter treatment tables. The system for shifting inspiratory gas is well functioning, and the patient is not disturbed. The application of NitrOx for parents has shown useful and supportive for treated child. The UPTD for the accompanying person using NitrOx on table 6 is 358.6 (850 is the highest permitted). If air and oxygen is used the UPTD will be 637.

*Conclusions*

Treatment units taken care of diving accidents should be prepared to treat children with decompressions injury. Simple measures can be taken to provide a safe treatment for the young patients and the accompanying person.

PP-03

**TREACHEROUS TREATMENT OR REASONABLE RISK?**

Stephenson R.[1], Bryson P.[2]

[1] Hyperbaric Medicine Unit, NHS Grampian, United Kingdom
[2] Director of Medical Services, ABERMED UK, United Kingdom

Keywords: Case report, Oxygen toxicity, Procedures/Protocols/Regulations/Guidelines/Standards

*Objectives*

Sensitivity to pulmonary oxygen toxicity and pulmonary fibrosis have been reported in patients who have undergone treatment with bleomycin. Bleomycin is an antitumour antibiotic drug that has been used for the treatment of germ cell tumours, lymphomas and selected squamous cell carcinomas. Concerns have been raised in relation to SCUBA diving post bleomycin therapy due to possible bleomycin induced pneumonitis. Such lung injury may precipitate pulmonary oxygen toxicity from increased inspired oxygen at ambient pressure when diving, during nitrox use and more worryingly hyperbaric oxygen therapy should it be required for the treatment of decompression illness.

*Methods*

The literature has mixed views, for some authors previous bleomycin treatment constitutes an automatic disqualification from SCUBA diving (DAN www.diversalertnetwork.org). However, others believe that resuming SCUBA diving 6-12 Months after 3-4 cycles of bleomycin may be acceptable and concern should be for those who develop signs of pulmonary function impairment during or shortly after therapy. (De Wit. The Lancet 2007: Vol. 8)

*Results*

We present the case of an individual who has undergone treatment for testicular cancer and who has successfully been SCUBA diving as an instructor for the last ten years, including during his cancer treatment.

*Conclusions*

This diver has continued to dive following and during bleomycin therapy with no pulmonary issues. The issues for the diver who has been treated with bleomycin and policy will be discussed.

PP-04

## RISK-TAKING BEHAVIOURS AND DIVING INJURIES AMONG WESTERN AUSTRALIAN RECREATIONAL SCUBA DIVERS

Buzzacott P.[1], Rosenberg M.[1]

[1] School of Sports Science, Exercise and Health, The University of Western Australia, Australia

Keywords: Complications, Recreational diving

*Objectives*

How risk-taking affects the likelihood of suffering a diving injury is unknown in Western Australia (WA). The aim was to measure the prevalence of risk-taking and diving injuries among certified recreational divers in WA and to identify risk factors for future investigation.

*Methods*

Dive centres in WA posted a four-page questionnaire to 1,974 entry-level scuba course graduates. Participants (n=499, 25%) returned questionnaires anonymously. Of 499 responses, 383 (77%) had dived during the previous year and supplied data for risk-taking and diving injuries during this period, dive certification level, number of dives per year since basic certification, age and sex. Logistic regression with backwards elimination (P=0.05) assessed the association between reporting a diving injury and potential risk factors.

*Results*

Males (n=295, 77%) were a mean age of 32 years (SD 11) and females (n=88, 23%) a mean of 30 years (SD 10). Compared with uninjured divers, divers who reported a diving injury within the previous year were more likely younger (29.5 years vs. 31.6), female (30% vs. 22%), to have additional diver training (44% vs. 37%), to have more dives per year (37 vs. 31) and to report more types of risk-taking during the previous year (1.7 vs. 1.3). After elimination, the only remaining factor associated with reporting a diving injury was the number of types of risk-taking behaviours (OR 1.4, 95% CI 1.1-18, P<0.01).

*Conclusions*

In this study known types of risk-taking (diving inside caves, inside shipwrecks, alone) was associated with reporting a diving injury, whereas sex, age, certification and diving experience were not. At OR=1.4, the likelihood of reporting an injury doubled for every two types of risk behaviour a diver reported taking during the previous year.

PP-05

## CASE STUDY: NEAR MAXIMAL VENOUS BUBBLE SCORES AND ARTERIAL BUBBLES WITH NO SIGNS OR SYMPTOMS OF DCS

Blogg S.[1], Gennser M.[2]

[1] SLB Consulting, United Kingdom
[2] Dept. of Environmental Physiology, Royal Institute of Technology, Sweden

Keywords: Decompression tables/algorithms/procedures, Research

*Objectives*

These observations were made during a trial designed to provide data for new military tri-mix diving tables.

*Methods*

Subjects performed wet dives in a hyperbaric chamber. An Interspiro IS-Mix (a semi-closed re-breather) delivered tri-mix gas resulting in a ratio of $O_2$/He/$N_2$: 21%/35%/44%. Buhlman and DCAP model derived profiles were tested to 40m (500 kPa) or 60m (700 kPa). The subject in question was an experienced, fit, healthy diver, who had no recent dive accidents or bodily trauma. He performed a DCAP 40 m dive with no incidents. Post-dive, Doppler bubble monitoring (Kisman Masurel grading system) and 2D echocardiograms were made.

*Results*

Five minutes post-dive, maximal KM Doppler bubble grades (KM 4) were heard at rest and flex. Similarly, 2D ultrasonic images produced a resting Eftedal Brubakk grade of 4(C) in the right heart, and grade 3 in the left heart. On flex, the venous heart was a 'white out'. Subsequent scores remained maximal, so at 60 min post-dive, despite the absence of signs or symptoms of decompression sickness (DCS), surface $O_2$ was administered. After 30 minutes, resting grades had reduced (KM 3+), but flex grades were still maximal. After 60 min total $O_2$, the resting grade was zero, the flex was 3+.

*Conclusions*

Inspection of the images suggested that a patent foramen ovale (PFO) was present, though it was not confirmed clinically. That such enormous bubble loads were present without concomitant DCS shows that the key factor in understanding the link between bubble evolution and the onset of DCS is still lacking.

PP-06

## FATAL DIVING ACCIDENTS IN ALPINE WATERS: DOES THERE EXIST A RED THREAT?

Schipke J.[1], Pacher A.[2]

[1] Research group Experimental Surgery, University Hospital Düsseldorf, Germany
[2] Legally Sworn Expert for Diving Issues, Austria

Keywords: Deep diving, Recreational diving

*Objectives*

After a series of fatal diving accidents in Alpine waters, it was analyzed whether these accidents had some points in common.

*Methods*

Between 1996 and 2009, 34 serious diving happened in Alpine waters of Austria. Of these, 32 accidents were fatal, 22 were legally examined, and computer profiles existed from 23 dives.

*Results*

Diving related characteristics were: male divers, planned dives to multiples of 10 m (e.g. 40 m or 60 m), discontinued ascent attempt after 6 to 9 min, death from 11 to 14 min. The time scale for tech divers seems somewhat delayed.

*Conclusions*

Diving accidents are similar with other accidents: they cannot be blamed to solely one fault, but to a chain of faults. Quite a few of the recurrent faults are remembered: missing appropriate health condition, missing physical training or further education, false security through high tech equipment, unknown rental equipment, too much weight on the belt, dry suite, not appropriately maintained equipment, improper configuration / lack of knowledge of equipment function, quality of breathing gas, considerable diving depth, and group obligation.

To circumvent that a chain of faults sums up to a life-threatening event, a descend stop at 5 m is recommended that is similar with the safety stop while ascending. The duration of the descend stop might vary and should last, until inner peace is found. It is further recommended to make a stop every 10 m, in case a new problem has occurred or needs being resolved.

PP-07

**DIVE ACCIDENT DURING DEEP DIVEX 2010 – MANAGEMENT AND OUTCOME**

Branco J.[1], Guerreiro F.[1], Alves A.[2], Amaro C.[2], Pinto C.[2], Pereira S.[2], Lopes L.[1], Pereira C.[1], Albuquerque e Sousa J.[1]

[1] Medical Department, Portuguese Navy Hyperbaric Center, Portugal
[2] Portugese Navy Hyperbaric Center, Portugal

Keywords: Case report, Deep diving, Hyperbaric chamber/system/facility

*Description*

The Deep Divex 2010, is a deep dive military exercise involving countries that use Viper Plus® diving equipment, which was held in Portugal in October and November 2010.

In the sequence of that exercise, an equipment failure caused a catastrophic hyperoxia on one diver, with loss of consciousness, seizures and near-drowning.

His buddy, being aware of the situation, took the appropriate measures to protect his mate's airway, and proceeded with a blow-up ascent to the surface from 78 meters.

Although this procedure saved the unconscious diver's life, it produced a serious multisystemic Decompression Illness on the other – dysbaric shock, presenting with consciousness depression, tetraplegia and serious dehydration.

The casualties were recompressed immediately on site and evacuated afterwards to the Portuguese Navy Hyperbaric Center, were they were subjected to an aggressive regimen of both recompressions and physiotherapy, with good response and a good outcome.

One of the divers returned to dive without restrictions and the other is almost one hundred percent recovered, able to do exercise, like biking, and will probably return to dive soon.

PP-08

## RAPID ASCENT AND BUOYANCY PROBLEMS IN WESTERN AUSTRALIA

Buzzacott P.[1], Pikora T.[2], Rosenberg M.[1], Heyworth J.[2]

[1] School of Sports Science, Exercise and Health, The University of Western Australia, Australia
[2] School of Population Health, The University of Western Australia, Australia

Keywords: Complications, Data collection/analysis, Recreational diving

*Objectives*

This study investigated risk factors associated with ascending rapidly and/or losing buoyancy control among certified recreational divers.

*Methods*

Dive and diver information were collected and depth/time loggers attached to recreational divers in Western Australia. Case dives recording an ascent >18m/min were compared with control dives made at the same dive site and time, by divers recording ascents ≤18m/min. In a second analysis, case dives with reported buoyancy problems were compared with control dives during which no problems were reported. Conditional logistic regression models identified factors significantly associated with ascending faster than 18m/min and reporting a buoyancy problem.

*Results*

In total 1032 dive profiles were collected. Case dives (n=71) recording an ascent >18m/min were compared with 282 control dives. The main risk factor for making a rapid ascent was a loss of buoyancy control. Dives resulting in reported buoyancy problems (n=68 cases) were compared with 320 control dives. The three main risk factors for reporting a buoyancy problem were an inability to describe how to check for neutral buoyancy, reportedly not being in control during the final ascent and maximum ascent rates that were a mean of 20% faster than during control dives.

*Conclusions*

Additional research is necessary to identify if ascending rapidly is the result of a loss of buoyancy control, a lack of ascent rate reference, or a failure to appreciate the potential consequences of ascending rapidly. The inability of many divers to describe how to check for neutral buoyancy at the start of the dive is also deserving of further research.

PP-09

## MEDICAL ASPECTS OF DIVING WITH DISABLED PERSONS IN THE SULTANATE OF OMAN

Prohaska R.[1]

[1] Austrian Society for Diving and Hyperbaric Medicine, Austria

Keywords: Recreational diving, Safety

*Objectives*

In March 2011 a 'Disabled Sports Festival' took place in Nizwa, Sultanate of Oman, organized by the Ministry of Sports Affairs. 550 participants with disabilities took part in different sports disciplines including SCUBA diving. To ensure safety of the diving programme diving physicians and diving instructors for handicapped did support.

*Methods*

Ambulance car, oxygen, and first aid kit were prepared on-site. Hospital and Hyperbaric Unit were informed and emergency lines checked. Diving equipment with special needs for handicapped (knee protectors, swimming gloves, small weights) was prepared.

Supporting Staff consisted of: 3 handicapped diving instructors, 1 assistant instructor, 1 surface assistant, 1 diving physician, 1 team coordinator. Hotel swimming pool was prepared for requirements of handicapped persons. Medical check-ups were done at the pool-side. For emergency assistance the diving doctor was present during all diving activities.

*Results*

38 medical check-ups were performed: 28 for disabled persons, 10 for personal assistants (teacher, therapist). 30 were fit to dive, 8 were fit to snorkel (reasons: lung diseases, ear problems). Coloured armbands indicated number of required dive buddies and whether participants were able to dive or snorkel.

During the event 38 divers had been in the pool. Among these were 8 blind, 8 mentally retarded, and 12 persons bound to wheelchair. 58 dives were performed (8 snorkel dives, 50 SCUBA dives), 20 disabled did more than one dive.

Problems among SCUBA divers: 1 paraplegic person felt uncomfortable after entering the pool when floating in diving gear and breathing through the regulator due to unusual breathing conditions and unstable position so that he didn't want to continue. However, his attempt the following day was successful.

Problems among snorkel divers: staff was unable to teach how to seal the snorkel with the lips in 3 cases (mentally retarded).

*Conclusions*

Handicapped people can do introductory dives safely and joyfully when the following points are considered: a staff with special qualification and experience in handicapped diving, a location adapted to the needs of the disabled, organisation according to safety standards and medical emergency procedures.

PP-10

## PHYSIOLOGICAL AND PSYCHOLOGICAL CHANGES AND CHANCES IN HANDICAPPED DIVERS WHILE OUR DIVING COURSE

Göbl A.[1], Olaj-Békés E.[1]

[1] Hyperbaric Centre, Hungary

Keywords: Projects, Recreational diving

*Objectives*

In Hungary we have trained 10 paraplegic (T10-11) young divers after methods of International Association for Handicapped Divers. We are looking the possibility to improving the physical and social well being of people with disabilities through the sport of scuba diving, and to controlling the benefits and potential risks of handicapped diving in rehabilitation.

*Methods*

We examined the patient's physical (anthropometry, blood cholesterol, RBP, EKG, lung function, arm-ergometry) and psychological (depression-test, subjective pain-level-scale and risk assessment test) parameters before and 2 weeks after the completion of diving course.

*Results*

The positive effect of diving is significant in all physical tests - as it was expected.

In psychical tests we have found essentially good changes, but some new risk/problems, too. The self-assessment and the social identity has improved, the social isolation fell over the period. Psychologically disabled divers perceived a pool workout in preparation for a dive as a "sports training" experience, rather than a "physical therapy" session. This changes the focus from dealing with a past injury and loss to looking forward to some future adventure and social-sportive fun was very positiv. But in some cases the risk-taking potential went significantly higher – as overcompensation in reaction to their disability. Five disabled divers in our group showed an increased risk undertaking behaviour.

Some disabled divers (with both acute and chronic disabilities) engaged in more risky behaviours as a form of overcompensation or denial of disability. The disabled divers are at greater risk for depression and mood swings than are divers without disabilities. While diving can do much to help alleviate this depression, monitoring mood is important, as extreme mood swings can affect judgment and risk-taking behaviour to prevent diving injuries.

*Conclusions*

The benefits of scuba diving for handicapped people include the introduction to a new environment with possibility of physical and social rehabilitation. There are new sensations for someone who is disadvantaged on land, but is now in an environment where he is, in many cases, equal to able-bodied divers. The physical and mental benefits of this are evident, according to diving instructors and physiotherapists who have worked with disabled divers checked significantly positive rehabilitation effect. But the diving instructors and the buddies should be monitored the emotional situation of disabled divers too, to reduced/prevent too high risk in diving activities.

PP-11

## EFFECTS OF RECREATIONAL TECH DIVING ON MEASURES OF RESPIRATION

Döring K.[1], Muth T.[2], Schipke J.[3]

[1] Medical Office for Internal Medicine and Sports Medicine, Giessen, Germany
[2] Institute of Occupational Medicine and Social Medicine, Heinrich-Heine-Universität Düsseldorf, Germany
[3] Research group Experimental Surgery, University Hospital Düsseldorf, Germany

Keywords: Oxidative stress, Recreational diving, Research

*Objectives*

Increased oxidative stress in tech diving could induce pulmonary injury. In an explorative study was investigated, whether repetitive, deep dives with oxygen-enriched air affect physiological measures.

*Methods*

On 10 experienced divers (1 female), physiological measures were assessed before and after a 10-days trip to the Croatian Adria (Cro). To estimate 'oxidative stress' dive time was multiplied by maximum depth. Blood gases were assessed from ear lobe capillary blood before, during and after exercise (bicycle). CO-diffusion was assessed at rest, while $O_2$ inspiration and $CO_2$-expiration were breath-to-breath-analysed during exercise. Additionally, basic medical examination, electrocardiogram, echocardiography and body plethysmography were performed.

*Results*

The divers (age: 32±8ys; BMI: 27±5; 410±423 preCroatia dives; mean±SD) did additional 11±4 dives using differently enriched air. The index of oxidative stress was 11000±4000min•m. Total lung capacity, vital capacity and forced expiration in 1s were slightly decreased after Cro. Oxygen partial pressure ($pO_2$) from rest to 300W was maintained (87.5±7.9 vs 85.4±9.7mmHg) before but decreased (90.4 ±7.2 vs 81.8±8.2mmHg) after Cro. Oxygen consumption / body mass at 300W was decreased after Cro (45.1±9.9 vs 41.7±9.8ml/min; $p<0.05$). In parallel, aerobic threshold (AT) was decreased (234±43 vs 186±39 l; $p<0.05$). From rest to 300W, pH before and after Cro decreased comparably (by 0.133 and 0.107).

*Conclusions*

Pulmonary injury is detected first by a decreased $O_2$ uptake which became evident on the bicycle at 300 W. While $pO_2$ was decreased, the $CO_2$ kinetics remained unchanged and AT was decreased.

Repetitive tech dives seem to induce – at least transient – pulmonary injury. Pauses during a dive trip or more conservative diving are recommended.

PP-12

## HEARTRATE VARIABILITY (HRV) DURING SCUBA DIVING WITH COMPRESSED AIR. A COMPARISON BETWEEN SWIMMING POOL AND OPEN WATER DIVING

Rehner F.[1], Kähler W.[1], Koch I.[1], Schipke J.[2], Kowalski J.[1], Koch A.[3]

[1] Section for Maritime Medicine of the Christian-Albrechts-University, German Naval Medical Institute, Germany
[2] Research group Experimental Surgery, University Hospital Düsseldorf, Germany
[3] Section for Maritime Medicine of the Christian-Albrechts Uni, German Naval Medical Institute, Germany

Keywords: Data collection/analysis, Recreational diving, Research

*Objectives*

Scuba diving shows growing popularity in elderly, too, but knowledge about the influence of changed ambient conditions, physical and/or psychic stress on diver´s autonomic nervous system is limited. Monitoring of heartrate variability (HRV) during diving provides insights in sympathetic and parasympathetic reactions.

*Methods*

13 experienced divers (42±10.32ys; 443±425 dives) in swimming pool, thereof 6 experienced divers (40±8.3ys; 362±405 dives) in open water. 2 pool dives with compressed air, 4m/26°C: Dive 1: 10min kneeling on the pool ground, 20min diving in a circle. Dive 2 without view, covered mask: 10min kneeling on the pool ground, 10min diving in a circle, 5min without mask. Open water dives, Lake Plön, 15m, 10°C, 30min. Holter-ECG lead before and during the dives, HRV-analysis (Lifecard, delMarReynolds). Analysis of low frequency (LF, sympathetic activity), high frequency (HF, parasympathetic activity), and LF/HF-ratio.

*Results*

Increases in LF (2016±1092ms2) and HF (449±285ms2) with decline in LF/HF (6.5±6,07ms2) while kneeling under water vs. controls (LF 1315±863ms2, HF 359±610ms2, LF/HF 8.04±7.01ms2). LF/HF ratio declines during diving in a circle (4.48±3.62ms2), kneeling (6.14±4.59ms2), without view (4.32±2.37ms2), without mask (3.3±3.4ms2), and open water (3.18±1.73ms2). Heart rate (HR) decline while kneeling (73±17.33/min) and slight increase during diving in a circle (84±15.49/min), at rest 80±14.93/min. HR higher in open water (91±29.29/min) with highest HR during descent (102±37.68/min).

*Conclusions*

The shift towards a higher parasympathetic activity characterized by LF/HF ratio during all pool tests and more distinct in open water, is most likely due to diving reflex and immersion and explains the overall restricted heart rate profile as well.

PP-13

**NEW INSIGHT IN NEUROVASCULAR HEADACHE IN DIVING**

Snoeck T.[1], Provyn S.[1], Parlak B.[2], Emonts P.[3], Clarys J.[4], Sesboüé B.[5], Balestra C.[1]

[1] Anatomy, morphology and biomechanics department, Haute école Paul Henri Spaak, Belgium
[2] Department of Bio engineering, University of Galatasaray, Turkey
[3] Radiology, University Hospital, Belgium
[4] Experimental Anatomy, Vrije Universiteit Brussel, Belgium
[5] Institut Régional de Médecine du Sport, France

Keywords: Complications, Recreational diving, Research

*Objectives*

There is a limited understanding of the normal function of the M. pterygoideus lateralis and the role that this muscle may have in temporomandibular disorder. However, the understanding of the anatomy and function of this muscle, with its possible variation (M. pterygoideus proprius), can be of importance for divers. Calcifications of this structure may cause entrapment of several branches of the N. trigeminus and/or the A. maxillaris. We can consider a possible ischemic effect in the jaw region that can explain the relatively common occurrence of myalgic pain reported in divers. This study reveals an in-vivo alternative 3D approach by MRI to visualize the M. pterygoideus proprius, if present, within the fossa pterygopalatina.

*Methods*

The fossa pterygopalatina of 39 subjects (18 female; 21 male) with a mean age of 32.7 ± 10.7 years old was examined bilaterally resulting in 78 sides. MR imaging were performed using a 1.5-T imager. All images were interpreted in the coronal and transversal view after transformation for muscular sequence using a DICOM viewer. In order to obtain a 3D multiplanar view, coronal and transversal slices were positioned using Matlab with an affine transformation and cubic interpolation for muscles. Statistical analysis was conducted using Prism for windows 5.03. Significance was set a priori at $p<0.05$.

*Results*

The results show an incidence of ~13% for the M. pterygoideus proprius equally divided for both genders. Two different morphology of bridging between the Mm. temporalis and pterygoideus lateralis were found.

*Conclusions*

This study allows for the quantification of the M. pterygoideus proprius variant and suggests the use of MRI 3D reconstruction to detect the different connections between vascular and muscular structures in the fossa pterygopalatina. Further research with this approach to link the appearance of the muscle with neurovascular entrapment syndromes during mouthpiece biting is warranted.

PP-14

**REDUCED ENDOTHELIAL FUNCTION BOTH IN SCUBA AND BREATH-HOLD DIVING, TWO DIFFERENT MECHANISMS?**

Theunissen S.[1], Guerrero F.[2], Germonpré P.[3], Balestra C.[1]

[1] Environmental & Occupational Physiology Lab, Haute école Paul Henri Spaak, Belgium
[2] UFR Sciences et Techniques, Université de Bretagne Occidentale, France
[3] Center for Hyperbaric Oxygen Therapy, Military Hospital Queen Astrid, Belgium

Keywords: Breath-hold diving, Recreational diving, Research

*Objectives*
Evaluate the effects of breath-hold and scuba diving on the endothelial function.

*Methods*

13 divers performed (8 SCUBA divers and 5 Breath-hold divers) performed either 1 scuba dive (air dive; 25 meter/25 minutes) or 5 dives at 20 meters breath-holding in a warm calm diving devoted pool (NEMO 33 Brussels, Belgium).

Flow Mediated Dilation (FMD) was performed using echography by means of a linear Mindray 5-10 MHz transducer before and after a 5 minutes ischemia. Plasmatic NO concentration was determined by nitrate/nirite colorimetric assay kit.

*Results*

According to pre-dive results, FMD decreases not only after a scuba dive of 25m/25 min (94.46+/- 7.12%; $p<0.05$) but also after five successive apnea of 20m (95.46 +/- 3.54%; $p< 0.05$). No difference is observed between both groups. An increase in circulating NO is observed for the apnea group according to pre-dive values (169.1 +/- 58.24; $p<0.01$). By contrast, no difference in circulating NO is observed for the scuba-diving group (100.5 +/- 37.47; $p>0.05$). The difference between both groups is significant ($p<0.01$).

*Conclusions*

Both scuba and apnea diving decrease FMD. Simultaneously, an increase in circulating NO is observed in the breath-hold diving group, though no variation in NO is observed in scuba divers. As demonstrated in several studies, scuba diving induces an inhibition of endothelial Nitric Oxide Synthase (eNOS) which induces a reduced reactive vasodilation showing a reduced FMD. During breath hold diving, a similar reduction can be shown, the identical diving conditions exclude the environmental interference, we can hypothesize an increased production of NO during physical effort, leading to a reduced FMD due to an impaired production of NO in endothelial cells. This hypothesis is encouraged by the circulating NO increase which is lacking in SCUBA divers. Apnea and scuba diving both reduce FMD but NO-dependent mechanisms are different.

PP-15

**ARE ANTHROPOMETRIC POPULATION SPECIFIC PREDICTION FORMULAE ESTIMATING PERCENTAGE ADIPOSITY SUITABLE FOR DIVERS?**

Provyn S.[1], Scafoglieri A.[2], Tresignie J.[2], Lumé C.[1], Balestra C.[1], Clarys J.[2], Snoeck T.[1]

[1] Anatomy, morphology and biomechanics department, Haute école Paul Henri Spaak, Belgium
[2] Department of Experimental Anatomy (EXAN), Belgium

Keywords: Modelling, Research

*Objectives*

Body composition is essential to understand decompression sickness. The mechanism of gas dissolution depends on tissue constitution. The most popular field method for estimating total body adiposity remains anthropometry separately or in formulae. The aim of this study was to verify the suitability of an absolute maximum out of more than 600 existing anthropometry equations estimating % body fat.

*Methods*

One hundred and twenty eight healthy adults (74 males mean age 34.4±14.1y and 54 females, mean age 30.9±8.5y) participated in the study. In order to provide the adequate variables for the population specific formulae, 14 skinfolds, 14 circumferences and 4 breadth measurements were taken on both genders. Dual energy X-ray absorptiometry (DXA) was used as the criterion for the estimation of percentage body fat.

*Results*

Three prediction equations only provided percent adipose tissue values with good correlation ($r \geq 0.70$; $p < 0.05$) and without significant difference ($p > 0.05$) compared to percent body fat as measured by DXA. Bland & Altman plots show ad hoc differences between these formulae and DXA with a range from 4% to 13%. However, only one formula (Pollock et al., 1976) falls within a biological and clinical acceptable range.

*Conclusions*

This study confirms that the use of body fat prediction equations is not reliable for individuals. Clinicians working with scuba divers on the prevention of decompression sickness should be cautious in interpreting body fat percentage values obtained using anthropometry based equations.

PP-16

## COUNTERACTING THE INERT GAS NARCOSIS: THE OXYGEN EFFECT HYPOTHESIS

Balestra C.[1], Blondel L.[1], Germonpré P.[2], Lafère P.[2]

[1] Environmental & Occupational Physiology Lab, Haute école Paul Henri Spaak, Belgium
[2] Center for Hyperbaric Oxygen Therapy, Military Hospital Queen Astrid, Belgium

Keywords: Nitrogen narcosis, Recreational diving, Research

*Objectives*

One of the possible risks incurred while diving is inert gas narcosis (IGN) which can provoke several troubles such as temporal and spatial disorientation, physical coordination alteration, mood disorders, loss of short term memory, etc. However, in a previous human study an increased cerebral arousal measured by Critical Flicker Fusion Frequency (CFFF) has been observed when arriving to the bottom suggesting an "oxygen effect". Further experimentation to determine the validity of this "oxygen effect" hypothesis was needed.

*Methods*

After informed consent, 20 volunteer male experienced divers enrolled for this study. They were selected in order to obtain a group of comparable age (30 – 40 years), body composition (BMI between 20 and 23) and health status. They performed 2 dives for a depth of 33 msw (wet dive) and 30 msw (dry chamber dive) for 20 minutes as to stay within accepted "no-decompression limits" (US Navy Diving Manual, Rev. 6, 15th April 2008). Divers were assessed with the CFFF before the dive, upon arriving at the bottom, 5 minutes before the ascent, and 30 minutes after surfacing.

*Results*

In both condition, wet and dry, a statistically significant and equivalent increase of CFFF was observed while arriving at depth (wet dive: 4.0±5.1% vs dry dive: 3.4±5.4%). The narcotic effect was only marked in the wet condition with an impairment of 6.5±4.3% of CFFF that persisted 30 minutes after surfacing, with CFFF still decreased by 3.7±8.2% compared to pre-dive. In dry condition CFFF values only return to the pre-dive values without post-dive impairment.

*Conclusions*

This study seems to confirm the oxygen effect due to increased partial pressure of oxygen, independently of the environmental conditions. The understanding of these adaptive mechanisms as well as their relative speed of action seems to deserve further investigations.

PP-17

## THE NORMOBARIC OXYGEN PARADOX: DOES IT INCREASE HB?

Theunissen S.[1], De Bels D.[2], Devriendt J.[2], Germonpré P.[3], Lafère P. [3], Valsamis J.[2], Snoeck T.[1], Meeus P.[1], Balestra C.[1]

[1] ISEK Environmental Physiology Lab, Belgium
[2] Brugmann University Hospital, Belgium
[3] Military Hospital Queen Astrid, Belgium

Keywords: Adjunctive treatment

*Objectives*

A novel approach to increase erythropoietin using oxygen has been reported in healthy volunteers. The purpose of this study is to investigate whether the EPO increase is sufficient to induce erythropoiesis.

*Methods*

We compared exposure to daily versus every other day oxygen administration on haemoglobin variation during a 12 day period. Each subject underwent the 2 protocols at a 6 week interval period to achieve the same baseline values.

*Results*

Nine subjects underwent the study. We observed a significant increase in haemoglobin values in the every other day group compared to the each day group and to baseline. At the end of each day period, haemoglobin values increased to achieve a significant difference as compared to baseline. There was a significant rise of reticulocytes in the every other day group as compared to the each day group (182±94% vs 93±34%, $p<0.001$).

These data provide demonstration of an enhanced production of erythrocytes.

*Conclusions*

The “Normobaric Oxygen Paradox” (NOP) seems effective to increase haemoglobin in non-anaemic healthy volunteers assuming there is a sufficient time interval between two oxygen applications. This could permit interesting clinical applications in perioperative medicine as an adjunct therapy to EPO for blood predonation.

PP-18

## ELECTRONICALLY VALIDATION OF GALVANIC $O_2$ SENSORS

Sieber A.[1], Krozer A.[1]

[1] IMEGO AB, Sweden

Keywords: Commercial diving, Recreational diving, Scientific diving

*Objectives*

In rebreathers galvanic $O_2$ sensors are used for measurement and control of the $PO_2$ in the loop. Either several sensors together with a voting logic or validation with gases are performed in order to detect sensor failures. In current limited cells, high $PO_2$ are reported lower than the real value which can be life threatening. This paper addresses electrical validation of $PO_2$ sensors.

*Methods*

Voltammetry is a technique, where a DC voltage is applied to an electrochemical sensor cell and the current is recorded. In order to be able to perform measurements on commercially available galvanic cells, first the sensor electronics has to be removed, as it would falsify the recordings. The board was replaced with a custom made electronics based on an ATXmega microcontroller. The digital to analog converter allows applying voltages to the sensor and the current is measured with the inbuilt AD converter.

*Results*

Several $O_2$ cells form Analytical Industries and Envitec were modified with the replacement electronics. Voltammetry was performed with bias voltages from 0 to +0.7V. New sensors have a characteristic plot with a rather constant current from 0 to 0.4V and above a fast decrease. Current limited cells have a different plot with a much smaller slope.

*Conclusions*

Voltammetry allows characterization of anode exhaustion of galvanic $O_2$ sensors. Possibly based on that, even a remaining lifetime prediction is possible. The new electronics allows further digital sensor readout, temperature compensation and sensor history storage ($O_2$ exposure hours).

PP-19

## A SAFE WAY TO DEFIBRILLATE INSIDE A PRESSURIZED HYPERBARIC CHAMBER

Arnell P.[1]

[1] Sahlgrenska University Hospital, Sweden

Keywords: Equipment

*Objectives*

The aim for this project was to develop an option to defibrillate inside our multiplace chamber during treatment and to establish practice on how this should be done in a safe way for both tender and patient.

*Methods*

A committee to make an extensive risk analysis was formed. It included representatives from the medical technical department, personal from the hyperbaric dept. and one person from the chamber manufacturer GDA. (Göteborgs dykeriteknik).

The report concluded that defibrillation could be done in a safe way with the defibrillator placed outside the chamber and the def pads connected to the patient on the inside by the tender that always accompanies the patients in our multiplace chamber.

*Results*

The defibrillator (Lifepac 20) is placed outside the chamber and the defibrillation cord is taken through the chamber wall and connected to def. pads on the inside. Delivered energy has been measured and is in acceptable range. The defibrillator is placed in a way that allows direct visual contact between the operator and the tender inside. The risk analysis concluded in some modifications on the chamber that was done, for example was the floor covered with a plastic carpet to prevent electric leakage. Some modifications of the grounding were also done.

A protocol on how a cardiac arrest inside the chamber should be handled was developed, including how defibrillation during treatment should be managed.

*Conclusions*

A system to in a safe way defibrillate inside the pressurized chamber has been established in our multiplace chamber.

PP-20

## HYPERBARIC OXYGEN FOR OSTEORADIONECROSIS OF THE FACIAL BONES: RETROSPECTIVE STUDY

Amaro C.[1], Pereira S.[1], Costa T.[1], Alves A.[1], Paulo V.[1], Branco J.[1], J., Guerreiro F.[2], Albuquerque e Sousa J.[1]

[1] Portuguese Navy Hyperbaric Center, Portugal
[2] Subaquatic and Hyperbaric Medicine, Portuguese Navy Hyperbaric Center, Portugal

Keywords: Critical care, Data collection/analysis, Wound care

*Objectives*

The present study was undertaken to evaluate our recent experience with mandibular osteoradionecrosis (ORN) and to identify factors that may contribute for a better treatment result.

*Methods*

Retrospective study involving 54 patients who had been treated for ORN during a 5-year period (2000-2005). Significance was evaluated with PASWStatistics18.

*Results*

There was clinical improvement in 45 (83.3%) patients treated with hyperbaric oxygen. In two (3.7%) treatment had to be stopped. The medium of time elapsed between radiotherapy and symptoms of ORN were 5 years (maximum 28 years; minimal 6 months) and between symptoms and hyperbaric oxygen was 14 months (maximum 72 months; minimal 1 month). Prognostic factors such as age, radiotherapy time and treatment delay time did not significantly affect the response to therapy ($p= 0.54$, $p=0.26$, $p=0.34$ respectively).

*Conclusions*

Hyperbaric oxygen is well tolerated and is effective in ORN treatment. ORN can occur several years after radiotherapy. More studies are necessary to identify other prognostic factors.

PP-21

## HYPERBARIC OXYGEN THERAPY USE AS AN IMPORTANT PART IN TREATMENT OF THE DIABETIC FOOT SYNDROME

Leichenbergová E.[1], Miček J.[2], Palušková M.[1], Nemcová Z.[3]

[1] Center of Hyperbaric Medicine, AMV Medical s.r.o., Slovakia
[2] Department of Vascular Surgery, Faculty Hospital Nové Zámky, Slovakia
[3] Slovak Medical University Bratislava, Slovakia

Keywords: Data collection/analysis, Research, Wound care

*Objectives*

Diabetics are at high risk for foot wounds, that are serious complications of the diabetes mellitus. As diabetic patients lose sensation in their feet, they are alerted to the injury, because blood and oxygen supply is limited by the damaged nerves, blood vessels and infections often don't heal. The incidence of the diabetes mellitus is on the rise and the complications of the disease too. When the damage is severe, the amputation of the lower leg may be as a life-saving measure.

*Methods*

The authors present their file of 85 diabetic patients with diabetic foot syndrome. These patients were treated in Center of Hyperbaric Medicine and the combined therapy included hyperbaric oxygenation, surgical intervention and appropriate pharmacology treatment / antibiotics, drugs for better vasodilatation, painkillers, etc.

*Results*

We have seen over 21 months / from July 2009 to April 2011 / that our therapy of the patients with diabetic foot wounds brings dramatic results.

*Conclusions*

For good results the therapy needs to last minimum of 20 days, regardless of any clinical improvements in the patients´ condition. Mobility, independence and live quality are very important for normal living at any age and after accurate combination therapy has a great potential to improve the quality of patients´ life in a significant way.

PP-22

## CLINICAL AND MOLECULAR EFFECTS OF HYPERBARIC OXYGEN IN DIABETIC FOOT ULCERS – PRELIMINARY DATA

Mendes D.[1], Fernandes T.[2], Camacho O.[2], Lima J.[3], Soares R.[1]

[1] Department of Biochemistry (U38-FCT), Faculty of Medicine of the University, Portugal
[2] Hyperbaric Medical Unit, Hospital Pedro Hispano, Portugal
[3] Cancer Biology Group, Institute of Molecular Pathology and Immunology of the University of Porto, Portugal

Keywords: Case report, Research, Wound care

*Objectives*

Wound healing involves several mechanisms, including extracellular matrix synthesis, angiogenesis, epithelization and scar remodeling. The majority of these processes depend on oxygen content. As a consequence, chronic wounds are the result of associated conditions that exhibit local hypoxia.

In diabetic environment, healing process is modified with change in number and function of circulating endothelial progenitor cells (EPC), decreased microvascularization of the inferior limbs and lower levels of vascular endothelial growth factor A, a wide variety of processes that are associated to the oxygen withdrawal. Thus, hyperbaric oxygen therapy (HBO) is used in hypoxic diabetic foot ulcers (DFU).

The authors are conducting a study to evaluate macroscopic evolution of DFU in patients under HBO treatment in comparison to untreated ones, and analyze molecular effects and action mechanisms of HBO, namely number of blood vessels, angiogenic, vasculogenic and inflammatory markers, EPC mobilization and oxidative stress (oxygen and nitrogen reactive species).

*Methods*

The study was approved by the Hospital Ethics Committee and is in accordance with the Helsinki Declaration.

Molecular analyzes are done in lymphocytes obtained from peripheral blood samples, blood serum, and skin fragments from DFU in different times of treatment.

Clinical endpoints (determined at 3, 6, 9 and 12 months) include: primary – percentage of wound epithelization; secondary – amputation, time till complete healing, improvement in neuropathy scales, infections, hospital admissions, ulcer recurrence.

*Results*

Data on the first three patients treated with HBO that entered the study will be presented including clinical endpoints at 3 and/or 6 months and molecular preliminary data.

*Conclusions*

HBO treated patients presented a positive clinical evolution.

PP-23

## A RETROSPECTIVE STUDY OF DIABETIC FOOT ULCERSTREATED WITH HYPERBARIC OXYGEN THERAPY

Bishop A.[1], Mudge E.[2]

[1] DDRC, United Kingdom
[2] Wound Healing Research Unit, Cardiff University, United Kingdom

Keywords: Research, Wound care

*Objectives*

A retrospective review of patient medical records was conducted to assess what factors influence the outcomes of diabetic foot ulcers (DFUs) treated with HBO.

*Methods*

Data was collected from the records of 30 patients referred for HBO for the treatment of DFUs during a 2-year period. Patients were allocated to one of 4 outcome groups at each of 2 time points - (i) at completion of HBO and (ii) 3 months later. These groups were;

- Major/minor amputation now necessary (treatment failure)
- No or minimal improvement (treatment failure)
- Partially healed; major amputation no longer required; amputation level lower than anticipated prior to HBO (treatment success)
- Healed (100% epithelialisation) (treatment success)

Data collected were statistically analysed to investigate whether any underlying pathologies or confounding factors appeared to influence patient outcome.

*Results*

A total of 73.3% of patients achieved a successful outcome at the end of HBO and 70% remained successful 3 months later when one patient (3.3%) had a healed wound. 13.3% of patients were lost to follow-up at 3 months and one patient (3.3%) had a major amputation.

76.7% of patients had type 2 diabetes and most patients were on insulin (76.7%). Only one patient was diet controlled. The mean time since diagnosis was 17 years.

One patient (3.3%) received some HBO treatments once daily and some twice a day. All other patients were treated on a daily basis with weekends off. The mean number of treatments was 40 (range = 19 - 60).

Steroid therapy, previous minor amputation, type 1 diabetes, previous HBO, larvae therapy and the application of interactive dressings had a significant relationship with poor outcome at the end of HBO ($p < 0.05$). A higher HbA1c level was related to a more successful outcome at this time point. Three months later, PVD, previous minor amputation, and the application of interactive dressings all had a significant influence on outcome with affected patients more likely to be in the failure group ($p < 0.05$).

*Conclusions*

In this study, as in similar studies, results indicated that healing continued after the course of HBO was complete. Many of the outcomes observed to be significant in this study were not reported in previous studies on HBO for DFUs. The small sample size, the number of patients lost to follow-up and missing data could all have contributed to these differences.

A larger scale study focussing on the factors found to be significant in this study is recommended.

PP-24

## DRAMATICALLY CLINICAL RECOVERY IN A PATIENT WITH FRONTAL LOBE NECROSIS AFTER CARBON MONOXIDE POISONING

Karakuzu E.[1], Metin S.[2], Battal B.[3], Oz O.[4], Ocal R.[5], Yildiz S.[1]

[1] Undersea and Hyperbaric Medicine, Gulhane Military Medical Academy, Turkey
[2] Aerospace Medicine, Gulhane Military Medical Academy, Turkey
[3] Radiology, Gulhane Military Medical Academy, Turkey
[4] Neurology, Gulhane Military Medical Academy, Turkey
[5] Internal Medicine, Gulhane Military Medical Academy, Turkey

Keywords: Case report

*Objectives*

Carbon monoxide (CO) poisoning is an important health problem which can cause serious cardiac or neurological sequelae, even in severe cases resulting in death at the end. One of the rare complications of CO poisoning is personality change because of frontal lobe necrosis. We evaluate the effect of long-term hyperbaric oxygen (HBO) treatment in a patient with frontal lobe necrosis after high dose intoxication of CO.

*Methods*

We wanted to discuss a 28 year-old female patient who was found by her sister in an unconscious position after a short-term water heater poisoning. Within 3 hours, we applied first HBO therapy and followed-up in an intensive care conditions.

*Results*

Despite the application of HBO therapy immediately, an unconscious pattern, agitation, personality changes, amnesia and coprolali were developed. Frontal lobe necrosis was determined in MR imaging findings. We applied treatments for 2 hours daily at 2.5 ATA on 100% oxygen with HBO and patient got a significant improvement. Her consciousness changed day by day. After 23rd treatment of HBO, her speech, behaviour, agitation and coprolali recovered completely.

*Conclusions*

We think that HBO therapy is a useful treatment especially in a case of acute CO poisoning. Furthermore, HBO therapy should be started as soon as possible in such cases. Early treatment in selected patients will reduce the morbidity and mortality.

PP-25

## CASE REPORT: A SUCCESSFULLY TREATED CORTICAL BLINDNESS SECONDARY TO HEAD TRAUMA VIA HYPERBARIC OXYGEN TREATMENT

Ergozen S.[1], Yilmaz V.[2], Yildiz S.[3], Karakuzu E.[3]

[1] Hyperbaric Oxygen Treatment Service, Turkish Armed Forces Rehabilitation Center, Turkey
[2] Physical Medicine And Rehabilitation Department, Turkish Armed Forces Rehabilitation Center, Turkey
[3] Undersea and Hyperbaric Medicine Department, Gulhane Military Medical Academy, Turkey

Keywords: Case report

*Objectives*

We want to draw attention to dramatic improvement in visual acuity of a young patient who had a head trauma and treated via hyperbaric oxygen treatment (HBOT).

*Methods*

A 7-year old female patient was crushed by a school bus and injured from her head. At her first examination brain edema, left frontal linear fracture and axonal injury were diagnosed and her treatment began in an intensive care unit. During her physical treatment and rehabilitation period it was realized that she couldn't read some letters of words (approximately 6 weeks after the accident). The patient was applied 17 sessions of HBOT in a monoplace chamber at 2 atmospheres absolute (ATA). Each session took 60 minutes.

*Results*

Her first Eye Care Service consultation revealed bilateral cortical blindness with 2/10 visual acuity. After ten sessions of HBOT, her second vision examination showed improvement and visual acuity reached 6/10 at right and 8/10 at left eye. According to this improvement we decided to prolong her HBOT and 7 more sessions were applied. After the total of 17 HBOT sessions, the patient was discharged from the hospital without another visual acuity exam because of her social problems and with the recommendation of a control exam 4 weeks later. Her control visual exam approved bilateral total visual recovery of 10/10. Clinically she can read the words correctly.

*Conclusions*

Early applied HBOT can be beneficial in patients with cortical blindness secondary to head trauma, especially in young patients. However more studies are needed to evaluate the role of HBOT in the treatment of these cases.

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## HYPERBARIC OXYGEN THERAPY IN A LACTANT INFANT

Pereira C.[1], Guerreiro F.[1], Albuquerque e Sousa J.[1], Leal M.[2], Barata D.[3], Branco J.[1], Alves A.[1]

[1] Hyperbaric Medicine, Navy Hiperbaric Centre, Portugal
[2] Reconstructive Surgery, Hospital D. Estefânia, Portugal
[3] UCIP, Hospital D. Estefânia, Portugal

Keywords: Adjunctive treatment, Case report, Wound care

*Objectives*

In order to emphasize the role of Hyperbaric Oxygen Therapy as an adjunctive therapy particularly in acute ischemic wounds, we report a clinical case of an infant who presented with extensive areas of necrosis of left lower limb due to critical ischemia, during arterial catheterization procedure, with serious risk of integrity of limb.

*Methods*

Female, preterm newborn infant of 1.5 months, with scheduled cardiac surgery (performed for multiple cardiac malformations), who developed, during early peri-surgical period, lower limb acute ischemia. Without response to therapeutics (with anticoagulants, prostaglandins and antibiotics), extensive areas of damaged soft tissues had been revealed with evidence of necrotic and infected parts reaching half of left lower limb. Regarding to risk of amputation (three fingers had been already lost) the patient came daily to our Center (CMSH) to be submitted to hyperbaric oxygen therapy complementarily to concomitant surgical approach and medical treatment (both performed in an ICU of Central Pediatric Hospital). Twenty sessions have been performed (1.8 ATA, for 60' with $FiO_2$ 100% under hood system) during over three weeks coordinating actions in order to arrest progression of lesions.

*Results*

Good tolerability, by the patient and accompanying mother, was achieved. Although fair clinical improvement was observed (with decrease of septic issues, pain relief, reduction of necrotic and exudative areas) amputation was scheduled and HBO stopped considering to be reached aim to provide reduction of the amputation portion and enabling field for impending surgical reconstructive intervention. Tibial and peroneal subtotal ostectomy were performed with removal of foot bones (calcaneus was availed) and preservation of cutaneous and cellular subcutaneous tissue from plantar surface of foot.

*Conclusions*

1- HBO may be helpful as an adjunctive treatment in case of ongoing tissue necrosis.

2- HBO can be successfully performed even in young infants.

3- In case of ineluctable amputation, relation between risk and benefit should be considered in order to define time of onset and duration of HBO in very young infants, as minimizing area of amputation is a relevant goal.

PP-27

**HERPES ZOSTER OTITIS (RAMSAY HUNT SYNDROME) - CASE REPORT**

Stanojković V.[1]

[1] ENT department, Hospital Izola, Slovenia

Keywords: Case report, Indications

*Objectives*

The most common site of zoster infection in the head and neck, after herpes zoster ophtalmicus, is the affecting the ear.

Symptoms: Herpes zoster otitis may occur at any age, but it mainly does so between 40 and 60 years. The patient is generally unwell with a fever or subfebrile temperature; erythema and sesicles are to be seen on the auricule and the external meatus; regional lymphadenitis is present discrete); severe neuralgic pain is found; peripheral facial paralysis is found in 60%-90% of patients; vertigo and disorders of balance are present in 40% of patients with release nystagmus to the healthy side.

*Methods*

Pathogenesis: The disorder is due to viral infection. The portal of entry is unknown. The virus may spread by the bloodstream to the CSF and the meninges causing encephalomyelomeningitis with neuritis of spiral or vestibular ganglion.

Diagnosis: Inspection and otoscopy, audiogram, vestibular test. Electrodiagnosis of facial nerve function and Schirmer's test are also carried out. Additional investigations include viral serology and examination of the CSF. The latter shows a slight increase in the number of cells and protein content, due serous meningitis. The disease often extends to the labyrinth causing a neurolabyrinthitis.

Diferential diagnosis: Myringitis bullosa and idiopathic facials paralysis.

Treatment: This is mainly symptomatic by analgesics, vitamin B complex and electrotherapy of the parilyzed facial nerve to prevent disuse atrophy of the mimic musculature.

Course and prognosis: These are good for life, but poor for function. The facial nerve paralysis recovers slowly and often only partially. The cochleovestibular loss is usually irreversible.

*Results*

Case reports: Seventy-year-old man was admitted to the ENT department with Herpes Zoster Otitis (Ramsay-Hunt Syndrome) sinister. Inspection and otoscopy show vesicles in the auricle, meatus or on the tympanic membrane. The glossopharyngeal and vagus nerves are affected: presenting as paresis and eruption in the mouth and pharynx on left side. Schirmer's test is positive on left side. Audiogram shows cochlear and retrocochlear deafness- perceptive hearing loss with tinnitus. Vestibular test show spontaneous nystagmus.

Treatment: analgesics, B-complex, Piracetam (Nootropil) 1,2 gr 2x2 per day, long term corticosteroid (Diprofos 2ccm i.m.), soft laser (10W, 2000Hz), bioptron lamp and hyperbaric oxygen therapy on 1.6 ATA with pure oxygen (100%) 90 minutes 20 therapies, virostatics: Virolex - 800 mg 5x per day- 10 days . All symptoms except tinnitus have improved after 3 weeks: hearing is better, no dizziness, no pain, no vesicles (eruption) no vertigo, no nystagmus.

*Conclusions*

Hyperbaric therapy in combination with other treatment modalities, helps accelerate healing in the case of Ramsay Hunt syndrome.

PP-28

## SUDDEN HEARING LOSS: EFFECTIVENESS OF HYPERBARIC OXYGEN IN CASES WITH BAD PROGNOSIS

Amaro C.[1], Costa T.[1], Pereira S.[1], Radu L.[2], Alves A.[1], Vera Cruz P.[1], Branco J.[1], Guerreiro F.[3], Albuquerque e Sousa J.[1]

[1] Portuguese Navy Hyperbaric Center, Portugal
[2] Mathematics, Faculdade de Engenharia da Universidade Católica Portuguesa, Portugal
[3] Subaquatic and Hyperbaric Medicine, Portuguese Navy Hyperbaric Center, Portugal

Keywords: Data collection/analysis, Indications

*Objectives*

The degree and type of hearing loss, time elapsed and association of vestibular symptoms, are all considered to be prognostic factors for spontaneous recovery in sudden hearing loss. In this study the authors correlate these factors with recovery rate of sudden hearing loss treated with hyperbaric oxygen (HBO).

*Methods*

Retrospective study of 99 patients treated with HBO. Hearing loss degree and type were classified according to Bureau International d'AudioPhonologie and Rapport de la société française d'ORL respectively. Since patients were sent from several institutions, it was not possible to know which medication each patient had before coming to our centre. Fetterman and Huv classification was used to establish recovery. Significance was evaluated with PASWStatistics18.

*Results*

55 (54.45%) patients experienced total (≥25 dB) hearing recovery and 21 (20.79%) partial (10 to 25 dB) recovery. There was no recovery in 23 (22.77%) patients. Those who had major hearing losses and type E audiometry showed significantly better recovery results with HBO treatment ($p < 0.01$). Though delayed treatment implied worse results, it was not significant ($p=0.049$). Vestibular symptoms didn't affect recovery ($p=0.8$).

*Conclusions*

Cofosis and major hearing losses show better results with HBO treatment. More studies are necessary to confirm this hypothesis and to define other prognosis factors.

PP-29

## HYPERBARIC OXYGENATION FOR SUDDEN IDIOPATHIC SENSORINEURAL HEARING LOSS

Gajic A.[1], Kutlesic-Stevic S.[1], Cejic D.[1]

[1] Center for hyperbaric medicine and chronic wound treatment, Institute for physical and rehabilitation medicine Dr Miroslav Zotovic, Bosnia and Herzegovina

Keywords: Adjunctive treatment, Indications

*Objectives*

Idiopathic sudden sensorineural hearing loss (ISSHL) occurs in 5 to 20 patients per 100.000. Most frequently it occurs in middle aged population. Untreated ISSHL may results in permanent hearing loss. The etiology of this condition is not clearly identified, but may be of vascular, viral, traumatic or autoimmune problems. There are also some negative prognostic factors that influence a treatment, such as delay in beginning of a treatment or vertigo.

Aim of the study was to show our first results in a small group of patients with ISSHL treated with hyperbaric oxygenation and to try to evaluate those results.

*Methods*

In the period from 2008 to 2010, twelve patients have been sent from ENT department to our Center for a treatment. All patient received therapy with corticosteroids and vasodilatators. An average age of patients was 42 years. Since HBOT for ISSHL is not fully reimbursed by the Health Insurance Fund patients had to participate both for the treatment and for the hospital day (under age of 65). Financial situation was a rather restricting factor for the number of procedures and we agreed that all patients undergo 20 procedures. Since we experienced that 60 minutes at 2.0 ATA (protocol that we use for diabetic foot treatment) is safe for a treatment in a monoplace chamber we decided to apply it on ISSHL and to evaluate the results. All patients were sent by the same ENT specialist.

*Results*

Patients showed different level of improvement. In 4 patients clinical status has significantly improved. In 6 patients moderate improvement has been observed and in 2 patients the improvement was insignificant.

*Conclusions*

Our group of patients (12) was too small to extract a significant conclusion about validity of our treatment protocol. Since we found out that a total number of patients with ISSHL admitted at the ENT department was significantly higher than 12, we concluded that there is a lack of interest for such a treatment for ISSHL either due to the lack of knowledge or scepticism for HBOT.

PP-30

## ORGANIZATION AND 2-YEAR OUTCOMES OF THE FIRST STATE HOSPITAL-BOUND HYPERBARIC OXYGEN THERAPY CENTER IN ISTANBUL

Oroglu B.[1]

[1] Kartal Lutfi Kirdar Training and Research Hospital, Turkey

Keywords: Hyperbaric chamber/system/facility, Hyperbaric personnel, Indications

*Objectives*

Before 2009, hyperbaric oxygen therapy (HBOT) units were only in private centers and in university hospitals. In 2009 with the opening of the Turkey's biggest burn center in Kartal Research and Training Hospital, a HBOT unit was established in the Burn Center. Since it's the first burn center in Istanbul, the biggest city of Turkey, we wanted to share our journey from the beginning. Also, it's the only one connected to a state hospital.

*Methods*

Our HBOT unit is based on the bottom floor of Kartal Burn Center. It is a detached three floored building on area of 2500 meter squares. Our chamber which was built in Turkey is a multiplace chamber for twelve people. Our staff consists of two hyperbaric physicians, one chamber operator, six nurses, and two cleaning personnel. Two therapy sessions each lasting 125 minutes are done daily, and all sessions are attended by a nurse, inside of the chamber. Additional sessions are run when necessary and there is always a physician and a nurse on call for emergencies.

*Results*

The hospital we are bound to serves to the whole Asian side of Istanbul and Marmara region as a fully equipped hospital and emergency service. This brought us being consulted about a variety of patients from different departments along with burn cases. In two years time a total of 356 patients were accepted for treatment. Of these, 90 were carbonmonoxide intoxication. 77 diabetic foot, 11 radiation injuries, 20 crush injuries, 20 burn patients, 23 sudden hearing loss, 7 central retinal artery occlusions, 17 osteomyelitis, 17 peripheral vascular disease, 5 collagen tissue disease based wounds, 4 avascular disease of the bone, 5 venous ulcers, 59 other non-healing wounds were treated. Interestingly, decompression sickness cases were only two.

*Conclusions*

There still are some needs of the center and the system. Despite these, we think our center would make a good representative of HBOT application in our country.

PP-31

**EFFICACY OF HYPERBARIC OXYGEN THERAPY IN RADIATION-INDUCED HEMORRHAGIC CYSTITIS AND PROCTITIS. EXPERIENCE OF CRIS-UTH SINCE 2007**

Papoutsidakis E.[1], Desola J.[1]

[1] CRIS-UTH, the Hyperbaric Therapy Unit of Barcelona, Spain

Keywords: Adjunctive treatment, Complications, Indications

*Objectives*

Pelvic tumours of urologic and gynaecologic origin are frequently treated with radiation therapy. Hemorrhagic cystitis and proctitis are potential complications. These complications have been widely managed with hyperbaric oxygen (HBO) since the 1980s.

We evaluated the efficacy of HBO for the management of radiation-induced cystitis and proctitis in CRIS-UTH.

*Methods*

This is a simply descriptive analysis of eighty-one patients of whom 73 were men (90.1%), that were treated between 01/2007 and 01/2011 in the Hyperbaric Therapy Unit of CRIS-UTH in Barcelona. Their mean age was 66.9 ±49.5 (14-85). All them were suffering from pelvic tumors, of which 61 (75.3%) were prostatic, 7 (8.6%) rectal, 5 (6.2%) of bladder and 8 (9.9%) of gynecological primary origin. They received 100% oxygen in a multiplace hyperbaric chamber at a 2.3 ATA, by means of total hood, for 60 effective minutes, plus compression and decompression procedures. HBO was applied once a day, five days per week, for a mean of 38±43.5 (28-59) sessions per patient.

*Results*

The mean latency between the end of radiation therapy and the onset of hemorrhagic symptoms was 39±72.5 (1-144) months. Thirty-one patients (38.3%) required blood transfusion because of major bleeding episodes. Seventy-six (95.1%) showed clinical improvement after HBO. Sixteen (19.8%) experienced a decrease in the number of bleeding episodes, while 60 (75.2%) completed the HBO treatments without further recurrences. The remaining 5 patients (4.9%) were stable, with neither a change in the frequency of their bleeding episodes nor evidence of progression of the disorder. Nine patients (11.1%) suffered tympanic barotraumas, 1 (1.2%) experienced a hyperoxic episode whereas 71 of them (87.7%) did not manifest any HBO-related adverse effects.

*Conclusions*

Our results indicate that HBO was a safe and effective treatment modality for patients suffering from radiation-induced hemorrhagic cystitis and proctitis.

PP-32

**HYDROSTATIC PRESSURE EFFECTS ON RAT CNS CELLULAR AND MITOCHONDRIAL RESPIRATION**

Théron M.[1], Hemmer C.[1], Le Gal L.[1], Belhomme M.[1], Guerrero F.[2]

[1] EA4324 - Laboratory ORPHY, Université de Bretagne Occidentale, France
[2] EA 4324 - Laboratory ORPHY, University of Brest - Faculty of Sports Sciences, France

Keywords: High pressure biology, Research

*Objectives*

In vertebrates, exposure to hydrostatic pressure (HP) leads to the development of the high pressure neurological syndrome (HPNS). HPNS is a direct consequence of HP on neuron functioning, resulting in a hyperactivity of the central nervous system (CNS). Since HP can reduce metabolic activity and the rate of energy supply at systemic and cellular levels; the present work aims at evaluating the hypothesis of a contribution of a CNS energetic alteration to the HPNS.

*Methods*

Mitochondria were isolated and primary cell cultures prepared from Wistar rat CNS. Mitochondrial oxygen consumptions were measured using pyruvate and malate as substrates, in absence (state 4) and excess of ADP (state 3). Isolated cell metabolism was evaluated through oxygen consumption on glucose in DMEM-F12. All oxygen consumptions were performed at atmospheric pressure and at 10.1 MPa HP (compression speed 1MPa/min).

*Results*

CNS mitochondrial activity is not altered by an exposure to 10.1MPa HP in Rat: neither state 3 nor state 4 respiration rates were modified in the conditions of this experiment (respectively 19.6±4.0 and 26.5±6.6 nMol $O_2$/min/mg of proteins at 0.1 MPa and 9.9±1.8 and 6.9±1.0 nMol/min/mg at 10.1MPa). Surprisingly, cellular metabolism was strongly modified and raised from 0.39±0.08 nMol $O_2$/min/107 cells at 0.1MPa to 1.93±0.41 nMol $O_2$/min/107C at 10.1MPa.

*Conclusions*

These results show that HP exposure does not induce alteration of mitochondrial activity, but has a strong effect on cellular energetic demand. Other experiments are needed in order to determine the target of HP in term of cell type and mechanism.

PP-33

**MODULATIONS OF CA2+ CURRENTS IN FROG PRESYNAPTIC MOTOR AXONS UNDER HIGH PRESSURE CONDITIONS: COMPUTER MODELLING**

Gradwohl G.[1], Aviner B.[2], Grossman Y.[2]

[1] Physics-Medical Engineering, Jerusalem College of Technology, Israel
[2] Physiology, Ben Gurion University of the Negev, Israel

Keywords: HPNS, Modelling, Research

*Objectives*

High pressure (HP) effects on terminal $Ca^{2+}$ currents (ICa) were studied in frog motor nerve. A computer model of the myelinated axon was constructed in order to understand HP influence on presynaptic ionic currents especially on ICas.

*Methods*

The model represented the axon terminal, the nodes of Ranvier and the intersegmental compartments. The node most proximal to the terminal (Nd1) contained gK and gNa while gK, gNa , and L- and N-type types gCa were inserted at the terminal. The extracellular current at the Nd1 was produced by local and reflected currents from the terminal that flow under the perineurial sheath.

*Results*

ICa initiated at terminal was measured at the node as an outward current. However, the nodal IK with similar activation time is also directed outward. In order to isolate the ICas which are mainly depressed byHP, from the IK, TEA was added in the experiments. This was simulated by reduced gK. Action potential invasion into the terminal (INa) is the primary cause for the ICa activation. Pressure can depress ICa directly or indirectly by INa decrease. Based on experimental and simulation results, we could show that HP diminished separately INa and ICa.

*Conclusions*

Considering the complicated temporal and spatial parameters of the various currents, our model was able to ‘mimic’ the experimental results and demonstrate that mainly N-type current is decreased at HP.

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## ALTERATIONS IN BLOOD GLUCOSE LEVELS IN RATS FOLLOWING EXPOSURE TO HYPERBARIC OXYGEN-INDUCED SEIZURES

Eynan M.[1], Krinsky N.[1]

[1] IDF Medical Corps, Israel Naval Medical Institute, Israel

Keywords: Oxygen toxicity, Research

*Objectives*

Despite extensive investigation, our understanding of the mechanism responsible for HBO-induced seizures is still incomplete. To date, no study has examined blood glucose levels and their association with the development of CNS-oxygen toxicity. Objectives: 1. To investigate whether blood glucose levels are reduced in non-diabetic rats following a single exposure or repeated exposure to an HBO therapeutic profile. 2. To investigate whether blood glucose levels are altered in non-diabetic rats following HBO-induced seizures.

*Methods*

The study was conducted on 3 groups of Sprague-Dawley rats. Group 1: Exposure to oxygen at 2.8 ATA, 90 min a day for 7 days. Group 2: Exposure to oxygen at 6 ATA until the appearance of convulsions to determine the animal's latency to CNS-OT; these rats were exposed again to HBO for 60% of the latency to CNS-OT. Group 3: Exposure to 6 ATA breathing a gas mixture containing oxygen at a partial pressure similar to that of air at 6 ATA. Blood samples were drawn before and after the exposures for measurement of glucose levels.

*Results*

No change was observed in blood glucose levels after exposure to oxygen at 2.8 ATA, 90 min a day for 7 days. Blood glucose levels were significantly elevated after exposure to oxygen at 6 ATA until the appearance of convulsions (56.3 ± 4.7 vs. 88.3 ± 9.5 mg/dl, $P < 0.01$). Blood glucose levels were also significantly elevated after exposure to 6 ATA for 60% of the latency to CNS-OT (56.8 ± 5.4 vs. 87.5 ± 15.3 mg/dl, $P < 0.01$). No change was observed in blood glucose levels after exposure to 6 ATA breathing a gas mixture containing oxygen at a partial pressure similar to that of air.

*Conclusions*

Our results demonstrate a possible correlation between blood glucose levels and HBO-induced seizures.

PP-35

## HBO TREATMENT FOR THE RECOVERY OF MUSCLE INJURIES INDUCED IN RATS

Cervaens M.[1], Camacho O.[2], Resende R.[2], Marques F.[3], Barata Coelho P.[1]

[1] Faculdade Ciencias da Saude, Universidade Fernando Pessoa, Portugal
[2] Unidade Medicina Hiperbárica, Hospital Pedro Hispano, Portugal
[3] Faculdade de Farmácia, Universidade do Porto, Portugal

Keywords: Data collection/analysis, Indications, Research

*Objectives*

The role of Hyperbaric Oxygen Therapy in the recovery of muscle injuries has been discussed for several years but is still yet to be well defined and accepted, even if the treatment of sports injuries is a common procedure at many HBO centres. The aim of this work was to evaluate the effect of Hyperbaric Oxygen therapy in the recovery of muscle injuries inflicted to witstar rats.

*Methods*

Six female rats, Rattus norvegicus albinos, witstar type, with weights between 200 and 250 g were used in this study. The animals were submitted to a muscle injury, using the Stratton method that consists in dropping twice a 200 g from 30 cm height (290 N impacts) over the right gastrocnemius of the rat. Animals were then randomly divided in two groups, the control group and the HBO group that was submitted to three 80 minutes session of HBO therapy at 2.5 ATA. The sessions occurred 24, 48 and 72 hours after the injury was caused. After the third session the animals were sacrificed and the right gastrocnemius removed as well as blood samples. The left gastrocnemius was used as internal control. All procedures were performed according to the FELASA recommendations for animal welfare.

The removed muscle was biomechanically analysed using a traction machine (EMIC, DL 10000) for parameters as hardness (H), maximum elongation (ME) and maximum weight (MW). Blood samples were analysed for haematological and biochemical parameters.

*Results*

For hardness the internal control group had $3.92 \pm 0.41\ 10^3$ N/m, the non treated group $2.24 \pm 0.38\ 10^3$ N/m and the treated group $3.19 \pm 0.32\ 10^3$ N/m.

For maximum elongation the internal control group had $13.40 \pm 1.61\ 10^{-3}$ m, the non treated group $10.91 \pm 2.20\ 10^{-3}$ m and the treated group $11.70 \pm 2.32\ 10^{-3}$ m. For maximum weight the results were 32.23 ±3.12 N for the internal control group, 18.27± 2.99 N and 26.18 ±2.84 N for the treated group.

For haematological parameters little difference was found between the treated and non-treated groups but for CPK significant differences were found for the non treated (6445.0 ± 387.3) and the treated group (4550.7± 79.5) were found.

*Conclusions*

Analysing either the muscle biomechanical properties and the muscle injury blood markers, HBO treatments seems to play a positive role in the recovery of induced muscle injuries. More studies should follow the present one to evaluate and optimise the recovery methodology.

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## BIOPHYSICAL METHOD OF CORRECTION DISORDERS CAUSED BY HYPERBARIA

Gulyar S.[1], Olszański R.[2], Skrzyński S.[2]

[1] Bogomoletz Institute of Physiology, National Academy of Sciences of Ukraine, Ukraine
[2] Military Institute of Medicine, Polska

Keywords: Commercial diving, Research, Saturation diving

*Objectives*

Increased pressure and density of gas environment at multiple repetition lead to chronic weakening of ventilatory functions, mainly in distal bronchial ways. During long hyperbaric exposures (deep-water saturated dives) insufficiency of electromagnetic waves of visible range is a powerful component in deterioration of the humane state. There are reports of a decrease of anti infectious stability revealed in nonspecific skin infectious diseases. Accumulation of residual post decompression microcirculation disorders in the musculoskeletal system promotes development of painful syndromes.

*Methods*

Estimation of a possibility to decrease respiratory disorders of hyperbaric origin was done in persons who were carrying out regular underwater dives. We studied dynamics of bronchial permeability variables under the influence of non saturated dives in nitrox range and saturated – in heliox. Pneumotachography was carried out after hyperbaric cycles. Correction was done by means of biophysical possibilities of BIOPTRON device light application. Its light is polarized (up to 95 %), polychromatic, of low intensity (40 $mW/cm^2$) and noncoherent (PILER-light). Piler light was applied on sterno-transpulmonal zones.

*Results*

PILER-light application to underwater dives on compressed air, promotes noticeable restoration of lungs ventilatory function. Zone applications of PILER-light during the period between dives reduced the initial development of a hyperbaric respiratory syndrome. PILER-light applications allowed to ventilation of accessory sinuses of nose and ear.

It resulted in improvement of respiratory ways, increase of maximum speeds of respiratory streams in bronchial tubes of small, average and large calibers. To compensate unfavourable (hyperoxic, hypoxic, peroxide oxidation) actions of leading hyperbaric factors in future simultaneous application of PILER-light and antioxidants (astax-10, kvercetin, the sixth element/pycnogenol) has been planned.

To increase contra infectious resistance immune normalizing modes of PILER-light applications are envisaged.

*Conclusions*

Experimentally confirmed that pain syndromes and microcirculation damages, caused decompression disorders in acute and chronic forms, can be reduced by direct and zone PILER-light therapy.

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## EXERCISE PARTICIPATION AMONG SATURATION DIVERS EMPLOYED IN NORWAY: A FOCUS GROUP STUDY

Tangelder Y. C.[1], Havnes M.[1], Gaustad, S. E.[1], Møllerløkken A.[1]

[1] Department of Circulation and Medical Imaging, Faculty of Medicine, Norwegian University of Science and Technology, Trondheim, Norway

Keywords: Divers, Focus groups, Exercise

*Objectives*

Saturation divers are physically exposed to extreme environments, as they work at great depths of seawater during longer periods of times. Divers can decrease their personal susceptibility to vascular bubble formation, a process that can cause serious damage and may even lead to decompression illness, by adopting an active lifestyle and exercise regularly. Main objective of the current study is to get a better insight in saturation divers individual, social and environmental barriers to and facilitators of exercise participation.

*Methods*

Saturation divers employed by subsea company Technip were recruited on board of the Skandi Arctic, an offshore subsea construction and dive support vessel, at that time mobilised in Haugesund, Norway. Divers were interviewed in focus groups of five or six participants each. Participants were asked to discuss open-ended questions about their exercise habits at work and in their time off. Additionally, participants filled out a short questionnaire.

*Results*

Being a saturation diver is an extraordinary profession and it may not be easy to exercise on a regular basis. When divers are in saturation there are not many workout possibilities. There is little space and little equipment. They are often tired after working. Some of them mention that they perform sit-ups and push-ups or use a rubber string to stretch once in a while. During the four to five days of decompression it is not recommended to exercise at all. When divers are off, on the other hand, most of them have good opportunities to exercise frequently and it seems that divers who are motivated manage to do so. Even though social and family goals were generally evaluated as being more important than exercise goals, many interviewees gave the impression that they live an active life. Most divers feel strongly that their lifestyle affects their performance at work. Several divers mention that you need to build muscles in order to be able to carry the heavy equipment.

*Conclusions*

Saturation divers live extremely disciplined when they are in saturation in contrast to their leisure time. Therefore, it can be a challenge to create stable exercise habits. However, it may be possible to increase exercise participation at work by improving the availability of workout equipment (e.g. rubber strings, fold away stepping machines). An exercise-encouraging intervention may improve divers exercise participation both in the chamber and during leisure time.

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