A Quest for Decompression

Advancing knowledge on the physiopathology of decompression, highlighting the risk factors for the formation of intravascular bubbles: it's the objective of PHYPODE, a European Union-funded project under the Marie Curie Initial Training Networks initiative.

Uniting academic and industrial partners, international nonprofit associations and hyperbaric medical centres on an international scale, PHYPODE aims to provide a collaborative training and research programme for twelve Early Stage and two Post-doctoral researchers, improving their skills and enhancing their career prospects.

Started in January 2011, the project will finish at the end of 2014.

An innovative, interdisciplinary approach

Decompression sickness (DCS) is caused by circulating inert gas bubble formation in blood vessels and tissues, resulting from supersaturation during inadequate decompression. It is an acknowledged risk of situations involving variations in ambient pressure, such as space flight and extravehicular activity, exposure to altitude, hyperbaric tunnelling intervention, as well as recreational and commercial underwater diving. Because of new industrial challenges (human space flight programs, deeper planed tunnelling interventions and offshore oil excavation) and emerging recreational demands, the range of both environmental conditions and population characteristics involved in such activities regularly widen. Thus, in order to reduce risk for DCS, new interdisciplinary approaches are needed, fostering knowledge of decompression phenomena by:

- developing an educational and research framework for the cross-fertilization of currently fragmented research activities concerning the physiopathology of decompression, with specific attention to the formation of intravascular bubbles
- providing young researchers with opportunities to share research techniques and resources, participate to courses, seminars, workshops and events in order to benefit from the best international scientists knowledge in this field, get the benefits of interactions and exchanges among industry, medical centres and academia
- widening the career prospectives of young researchers by enabling them to embrace the entire chain of research activities: from fundamental research for pathophysiological understanding of decompression, to applied research in the industry for management of decompression

The present understanding of the DCS mechanisms implies that there are at least 3 different kinds of symptoms involved in the onset of decompression sickness. It is believed that these symptoms correspond to three different bubble scenarios:

- central or vestibular symptoms, related to the presence of a vascular bubble in the brain
- spinal symptoms, related to the venous damping of the vessel draining the spinal cord
- articular symptoms, related to the presence of a large bubble in the tendons and the ligament of the articulation.

The PHYPODE project concentrates on research of the first two cases:

- mechanisms involved in intravascular bubbles formation during decompression,
- mechanisms linking intravascular bubbles to decompression sickness.

Mechanisms leading from decrease in ambient pressure to formation of intravascular bubbles and, then, to DCS are investigated using both epidemiological and physiological approaches, thanks to development of

technological devices. On the basis of data obtained from these investigations, industrial partners will develop devices for the management of decompression.

PHYPODE objectives, in detail
(taken from: “Oxygen in Decompression” by Dr Jacek Kot, MD, PhD, Deputy Medical Director DAN Europe Polska and Medical Consultant – 7th DAN Divers Day, Gdańsk, Poland, August 28th 2011)

- Epidemiological approach for determination of risk factors for intravascular bubble formation
- Clinical experimental approaches for determination of risk factors for intravascular bubble formation
- Impact of Patent Foramen Ovale
- Vascular endothelium as potential source/target for intravascular bubble formation
- Pre-dive conditioning for management of decompression
- Monitoring and control of dive parameters for management of decompression
- Epidemiological approach for determination of risk factors for DCS
- Role of vascular endothelium in the development of DCS
- Oxidative stress on the prevention (O2 breathing) and treatment (HBO) of DCS
- Treatment of DCS

Joining PHYPODE
In order to achieve the objectives of this ambitious training and research programme, 13 members among academic and industrial partners, not-for-profit associations and hyperbaric medical centres have formed an international consortium with complementary expertise in:

- Epidemiological research
- Prospective clinical research
- Experimental physiological approach, using fundamental and clinical research methodologies
- Technological development for the management of decompression

Partner short name	Partner full name	Country
UBO	**Universite de Bretagne Occidentale** EA 4324 – ORPHY (project director: F Guerrero)	FRANCE
GUMed	**Gdanski Uniwersytet Medyczny** National Center for Hyperbaric Medicine (NCHM)	POLAND
ISEK	**Haute Ecole Paul Henri Spaak – Institut Supérieur de l’Etat de Kinésithérapie** Environmental & Occupational Physiology Department	BELGIUM
DAN	**Divers Alert Network Europe**	ITALY

Partner short name	Partner full name	Country
HBOC	**Military Hospital Queen Astrid** Centre for Hyperbaric Oxygen Therapy	BELGIUM
AQUA3	**G.T. di Trampus Graziella – AQUA3**	ITALY
MARES	Mares S.p.A.	ITALY
USSM	**University of Split – School of Medicine** Department of Physiology	CROATIA
IMEGO	**IMEGO AB**	SWEDEN
HMC	**Hyperbaric Medical Center**	EGYPT
SU	**Stellenbosch University, Faculty of Health Sciences** Department Interdisciplinary Health Sciences (Field: Hyperbaric Medicine and Research)	SOUTH AFRICA
COMEX	**COMEX S.A**	FRANCE
NDS	French Navy French Navy Diving School	FRANCE

Some PHYPODE people

Prof. Costantino Balestra

Professor, how was PHYPODE born?

The PHYPODE project was born from a discussion of a few years ago with Dr François Guerrero of the university of Brest, whom I'd met as a member of the examining commission at his thesis presentation. Then

when the idea to launch a European research consortium on decompression mechanisms was born, I told François that I didn't have any more time to deal with it personally, but that I would have put him in

touch with the people most interested in this field. We thus proposed a project to the «Marie Curie», knowing well that the acceptance rate for proposals was very low, only 16%. A proportion in which we also ended up!

What is the role of DAN Europe in the project?

The role of DAN Europe has been fundamental since the beginning, in providing contacts and the necessary know-how to undertake a truly European project. Until today, PHYPODE is the only programme which will allow about ten researchers to work for three years full-time on the physiopathology of decompression. To crown these years of research the "DAN Deco Book" will be published.

Which aspects of decompression will be examined?

The work of researchers involved in PHYPODE will revolve around different decompression issues: reconditioning which also includes the concept of "wellness", the study of peripheral and central endothelial parameters; the automatic measurement of circulating bubbles in echocardiography, the objective measurement of narcosis; also the detailed analysis of available data (data-mining) and the

formulation of proposals for the adoption of individual decompression algorithms for divers.
In other words: there's a lot to be done!

Amir E. Fakhry

Amir E. Fakhry is a young Egyptian Medical Doctor wishing to develop his skills in the field of decompression phenomena. After gaining his bachelor degree in medicine and surgery at Ain Shams University of Cairo, he started his training in hyperbaric and diving medicine at the Hyperbaric Medical Center of Sharm El Sheikh, under the supervision of Dr Adel Taher, Regional Director of DAN Egypt.

Having all the prerequisites listed by the Marie Curie Actions (including a degree obtained not earlier than 2007), Amir applied successfully as an Early Stage Researcher (ESR) for the PHYPODE Project, and was offered a 36-month contract at DAN Europe Foundation, Continental Europe Office in Roseto degli Abruzzi (Italy). A lucky chance, since DAN Europe is one of the world leaders in medical and scientific research on diving safety, conducting several research projects on medicine and physiology in diving. The results obtained by its researchers have become a point of reference for the international medical scuba diving community. Volunteers from every country in Europe have been involved in collecting data according to scientifically and epidemiologically appropriate methodologies. Thus, the DAN Diving Research Laboratory database is collecting and analysing hundreds of thousands of real dives, which allow investigation on a number of different aspects of diving safety.

Amir's tasks in the frame of PHYPODE will include training divers for field data collection and supervising a multicentric epidemiological study on determination of risk factors for intravascular bubble formation.

Data sampling will include:

- questionnaires forms previously developed for recording diver characteristics and dive details;
- recording of dive parameters using diving computer specially adapted as "blackbox" to not interact with diver during unrestricted recreational diving;
- doppler examination of venous gas bubbles after each dive. Data will be entered into a software database prepared for the project by DAN Europe Research.