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# **DESCRIPTIVE CLASSIFICATION OF DIVING DISORDERS**

## 4th Report

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This 4th report includes some important modifications introduced after the 1st preliminary one that was initially edited within the Proceedings Book of the Congress.

All diving disciplines are exposed to a high potential of serious accidents, which can be considered inherent to this underwater activity. Some modalities or specialties imply a higher level of hazard, like deep mixed gas-diving in off-shore industry, or cave/speleological diving usually done by divers with a recreational or sport diving licence.

Other important risk factor is imposed by the underwater environment which by itself may convert into a tragedy, an incident that would have been irrelevant in the land. This is the case of the people being able to have a normal activity but with a silent or hidden disease that can produce a loss of consciousness underwater.

Different etiopathogenic factors are responsible for a quite wide variety of disorders. Some depend on the underwater environment and the physiological mechanisms of adaptation required of the human body. Others are linked to the variation of pressure implicit to any diving activity.

Almost all parts of the body can suffer from the consequences of a Diving Disorder (DD), so signs and symptoms can be extremely varied (Table 1). There is usually a coincidence of these different signs/symptoms and pathophysiological mechanisms in a diving disorder, and similar signs and symptoms may be due to different origins (Table 2).

As a result of this combination of factors, a wide range of diving disorders exists, and diving medical specialists frequently have difficulties in adequately classifying apparently similar diseases which are, however, produced by different mechanisms.

An additional factor to this classifying difficulty may come from the fact that diving injuries have been excessively associated with diving activity in itself, and therapeutical procedures were designed to be applied by divers, or by diving supervisors, usually in diving facilities, sometimes in non medically controlled hyperbaric chambers, generally forgetting basic medical disciplines, and avoiding routine procedures usually followed in medical centres.

A person suffering from a Decompression Disorder is not a diver that has omitted a decompression step, or an individual that has suffered an interruption of his underwater job, and he<sup>1</sup> does not need to be placed in a hyperbaric chamber just to complete his decompression schedule. An injured diver is a patient suffering from a multifactorial systemic disease, with a complex pathological mechanism of multifocal gas microembolism, frequently with haemodynamic and rheological alterations, affecting different structures of his body, and producing a wide range of signs/symptoms some of them paradoxal. He does not need "to be recompressed" but he must be sent to a Hyperbaric Medical Centre where he will be examined, studied and analyzed, and as a result of all that, he will receive the most adequate treatment for his complex disease, which usually will include, among other therapeutical procedures, the application of Hyperbaric Oxygenation (HBO) within a Hyperbaric Chamber. Obviously some high level diving medical centres have always existed in some countries, but this not generally the case.

Historically Diving Disorders were classified in two wide categories (type I and type II) corresponding to minor and major cases. In Type I those cases with only skin or limb pain symptoms were included. Type II corresponded to the rest of the signs/symptoms, where a large variety of conditions were mixed.

This classification not only made it impossible to separate different etiopathogenic mechanisms coinciding in one single patient, but in fact both types of disorders (type I and type II) very frequently coincide in the same diver. When we were listening an expression like "*a diver suffering from a type II decompression sickness*" we could not know what kind of process the patient was suffering.

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1.- In order to simplify the text and its reading, we will avoid the use of expressions like **he/she**, **he and she**, and we are using the masculine personal pronoun **he** in its impersonal neutral meaning. The reader should understand that we are always referring to men and women divers.

Many persons had mentioned their disagreement with this inexpressive classification, which was a common topic of discussion at any meeting of diving medicine. Some expert diving medical centres had developed their own classification based on their knowledge and experience. Meetings of EUBS and UHMS frequently showed those different attitudes.

An important contribution was given by FRANCIS & SMITH who a few years ago proposed a new approach to the description of diving disorders, more based on medical practice, introducing the term *Decompression Illness*, widely used after that. Experience demonstrated, however, that some problems remained unsolved and we did not manage to adopt unified classification criteria at that point.

European countries have a long tradition of diving medicine, and some centres have their own well-established protocols. The different European languages have difficulties to accurately translate some anglosaxon words; few European languages, for instance, can translate in different words *illness*, *sickness* and *disease*.

Adopting an unique common scientific language is certainly very difficult, but this is one of the main reasons why the European Committee for Hyperbaric Medicine (ECHM) wished to propose a mainly Descriptive Classification of Diving Disorders that can be used in different European areas, using different languages, in which basic concepts, more than technical words, will be introduced.

It is not an easy job, really, but here is an attempt to establish a common and unified approach to diving disorders, following approximately the same system usually adopted to describe the great majority of diseases that appear in books of medical pathology. This is a preliminary report that will be discussed in this II European Consensus Congress. Results of general discussion will be later incorporated and the resulting classification will be newly discussed if necessary.

## **METHOD**

These are the general rules followed for this classification.

Diving disorders can be classified according to different criteria. Some of this criterion are compatible and can be consequently incorporated. We have chosen 5 different groups that will not be excluding ones to others but, on the contrary, may be accumulated.

We have given special attention to concepts, more than to words, in order to establish similar classifying groups, in spite of the fact that a word or a technical concept may need to be expressed with different words when it is translated into an other language.

We have used English words but international concepts, trying overall to produce a classification that can be used, with minor changes, in all European languages. We have chosen basic English words selecting those more grammatically closed to other languages. In some cases you possibly will find a description or a sentence that is not exactly the most commonly used in English medical literature, but the reason is that among other synonyms or equivalent words, we have selected those with the same initial or similar pronunciation in other European languages.

As an attempt to establish a standard, we have finally suggested an Alpha-numeric code that would represent any of the most important groups of phenomena, and that would be used as a reference to be included in reports and communications, like is done, for instance, with the international classification of pneumoconiosis. These codes may have some special utility when an exact criterion is needed, for instance in order to establish therapeutical protocols, to join groups of patients, or to define reimbursement polices from insurance companies. This is not a classification to be used for short clinical reports in operational diving centres, or to be included

in the brief information given in the emergency room to the patients. For that purpose we have included at the end a **simplified classification**, very easy to follow, that will permit to a non specialized diving doctor (at least we hope so) to descriptively summarize the main pathogenic and clinical aspects of the most common diving disorders.

## PRELIMINARY REMARKS

**Terminology.** Diving disorders have been nominated of different forms. Recently the term DECOMPRESSION ILLNESS has become common. There are some reasons for which we consider this term inadequate. This opinion is mainly based in three facts:

1. Not all diving disorders are pressure related; some are underwater related independently of the pressure.
2. Not all pressure related disorders are decompressive; some happen during the compression phase.
3. The translation of *Illness* and *Sickness* to the majority of European languages corresponds to a single word. In consequence, this difference between sickness and illness can not be established. We believe more appropriate to reserve the word *Decompression* for the so called *Decompression Sickness*, so we will not make any difference between illness and sickness.

**Pathophysiology of diving disorders.** Many references to etiopathogenic fundamentals are done in the pages that follow, but obviously not all basic concepts are mentioned but only directly related to terminology and/or classification. The reader must understand all unmentioned principles of diving Pathophysiology.

**Key-codes and abbreviations.** In order to make easier the use of these codes, we will follow a mnemonic guide using when possible the initial of the word, or the letter more closely related to the concept that the word is representing. For instance, **A** and **V** are the keys corresponding to the words **Arterial** and **Venous**, but **X** and **M** have been selected as keys for the concepts **eXplosion** and **iMpllosion** instead of their initials. When two main words have the same initial, we have given preference to the most important one, in terms of frequency of use, more than in relevancy of the disease. For small locations, or few frequent concepts, we have used their three first letters, or the three more representative ones, shown in lower cases and separate by a point (ex.:mus.abd.neu). In two special situations we have considered more useful to indicate a zero (Ø) after a letter in order to better remark its negative or antagonistic effect. The code for DYSBARIC is the letter **D** and for NON-DYSBARIC is **DØ** (D-zero). The code for BUBBLE-RELATED is **B** and for NON-BUBBLE-RELATED is **BØ** (B-zero). This number zero should not be confused with the letter **O**. In order to avoid this kind of confusions, and taking more especially into account the common practice in some areas of saying **O** when they are reading a zero, we are using the sign **Ø** referred to the zero key code, and the conventional **0** for numbers, like 2000.

## CLASSIFICATION OF DIVING DISORDERS

Five different criteria have been adopted for classifying diving disorders (Table 3).

1. MORPHOLOGICAL. Attending to the affected part of the body.
2. CLINICAL. Based on the main syndromic groups of symptoms.
3. ETIOPATHOGENIC. According to the cause and to the mechanism of the disorder.
4. CHRONOLOGICAL. Depending on the phase of the diving activity in which the disorder occurs.

## 5. EVOLUTIONAL. Relative to the outcome of the patient.

Any diving disorder can, and must, be classified according to the five criteria. No group excludes another one. On the contrary any case can, and should, be entered in each one, and the final expression will include the five linked conditions. A SIMPLIFIED CLASSIFICATION for general use is also included at the end.

## 1.- MORPHOLOGICAL CLASSIFICATION

Depending on which part of the body is affected, the diving disorder will be **cutaneous**, **muscular**, **osteo-articular**, **Neurologic**, **Systemic**, or resident in other somato-splanchnic locations (Table 4). Cutaneous lesions may be **petechial**, **infiltrative**, **maculous**, or **emphysematous**. Neurologic forms may be **cerebral**, **cerebellar**, **medullar**, **peripheral**, or **neuropsychic**. Systemic forms can be **haemodynamic**, **rheologic**, **coagulopathic**, or all at the same time producing a new kind of **shock** that will be later discussed. Somatosplanchnic forms may be **otologic**, **sinusal**, **dental**, **thoraco-respiratory** and **abdomino-gastrointestinal**. In the otological area either the general code **oto** can be used, relative to a general location, or a most concrete one relative to a single organ, like **tympanic**, or **vestibular**. Similarly the code **res** can be generally used for all thoraco-respiratory locations, but more specific codes can be used for pulmonary (**pul**), pleural (**pnt**) or mediastinal (**pnm**) locations; the particles *ple* or *med* have been avoided in order to prevent confusion with other terms, specially taking also into account that **pneumothorax** or **pneumomediastinum** are the principal, or may be the only, disorders associated to this area in diving medicine.

## 2.- CLINICAL CLASSIFICATION

The well known major syndromes are included in this area, generally respecting the expression by means of which are widely known (Table 5). However some few ones need an explanation.

- **Decompression Sickness** (DCS). we have already discussed the reason why we reserve the words *decompression* and *sickness* just for this disease.
- **Intrathoracic Hyperpressive Syndrome** (IHS). A lot of different names are used among different areas in relation to the barotraumatism of the chest. The terms, *Arterial Gas embolism*, *Brain embolism*, *Traumatic Air embolism*, *Pulmonary overexpansion*, *Burst lung*, only refer to some elements of the syndrome. Gas embolism not always occurs in every kind of barotraumatic lesions of the lung; lung rupture due to overexpansion is not always seen in cases of gas embolism; the brain is not the only target organ for gas embolism although it is the more serious and frequent; some patients have pneumothorax and/or pneumomediastinum with no other neurological or respiratory signs or symptoms. All these factors however are conditioned by the relative increase of the intrathoracic pressure that the chest experiences when the external pressure is reduced and respiratory air is not adequately drained, which converts the thoracic cage in a pressure container. Gas embolism, pleural or mediastinal ruptures, subcutaneous emphysema, are caused by a mechanism of intrathoracic increase of tension. However the word *hypertension* should be avoided in order to prevent confusion with the *vascular pulmonary hypertension*. There are at least four different pathophysiological mechanisms that usually coincide in these patients although they may happen separately: the thoraco-pulmonary syndrome (TPS), the abdomino-gastrointestinal syndrome (AB), the arterial gas embolism (AGE), and a systemic syndrome (SS). Consequently, this is not a disease but a syndrome and we have considered that *Intrathoracic Hyperpressive Syndrome* (IHS) is the expression that more closely explains all mechanisms of this most serious diving disorder.

- **E.N.T. (or O.R.L.) Barotraumatism**s. They can be described using the generic syndromic terms common in medical practice, and the well known Edmonds classification. The use of English (Ear-Nose-Throat) or greek-latin derived initials (Oto-Rhino-Laryngology) will vary according different areas; both should be accepted.
- **Breath-hold Anoxic Syncope of Emersion** (BASE). This has been given in the past different names to the loss of consciousness that some breath-hold divers can suffer during the ascent.

The more widely diffused is the French "Rendez-vous sincopel des 7 mètres". This term may be confusing since the loss of consciousness, during the ascent in a breath-hold dive, does not appear exactly at 7 m. but may occur at any moment, if the necessary conditions are done. The term BASE seems more closely descriptive for this frequent, serious, and often undiagnosed entity.

- **Extreme Depth Apnoeic Pulmonary Oedema** (EDAPO or EDAPE). Although it is not a widely practised diving activity, some individuals are diving at extreme depths, and making possible the development of pulmonary alterations as a result of the paradoxal mechanism of adaptation to this out of limit activity.

### 3.- ETIOPATHOGENIC CLASSIFICATION OF DIVING DISORDERS

Diving Disorders are here classified according to their origin and pathophysiological mechanism. Two main preliminary groups exist. Those mainly related to changes in the environmental pressure (DYSBARIC), and those other ones that would be irrelevant if they occurred in the land but they become serious while diving due to the implication of the underwater environment.

**NON-DYSBARIC DIVING DISORDERS** (Abbrev.: NDDD - Code: **DØ**). They are not specific of diving, but they can be classified in three wide groups. Some may occur after suffering an aquatic Traumatism (boats, rocks, propellers) or an aggression from aquatic animals (Table 6), or after catastrophic damage caused by the diving apparatus (explosion of air cylinders, rupture of high pressure pipes, or hyperbaric chamber defects).

A second group of NDDD result as a fail of the individual mechanisms of Adaptation to the underwater environment, like hypothermia, thermo-differential shock, or kinetosis.

The disorders included in the final group are caused by the appearance of non diving related disorders or diseases that will be a real hazard if they are Coincidental with diving. They can be pre-existent silent diseases, which must be considered as a cause of unfitness to dive (seizures, diabetes, asthma, cardiac disorders). Other group of disorders remain hidden or unknown, but when they coincide with diving, the drowning of the diver can result, like is the case of any situation that can produce a loss of consciousness.

The most important group of Diving Disorders are directly related to changes in environmental pressure, either hyper or hypobaric (Table 7). Some ones deal with bubble formation in the body and in other ones this phenomenon does not occur, in spite of the fact that all are pressure-related so they properly constitute the group of **DYSBARIC DISORDERS** (Abbrev.: DD - Code: **D**).

The first group correspond to **NON-BUBBLE-RELATED** (or NON-BUBBLE-FORMING) disorders in which no bubble is formed so there is no embolic or infiltrative pathogenic factor (Code: **BØ**). These changes will cause modifications in both the solution and the morphology of all organic gases. Some **gas soLution dependent** disorders (Code L) are *Breath-hold anoxic*

*syncope of emersion* (BASE), *Extreme depth apnoeic pulmonary oedema* (EDAPE), *Inert gas narcosis* (IGN) and *High pressure neurologic syndrome* (HPNS). All disorders produced by the toxic effects of breathing gases will also be included in this group, like the *Acute Cerebral Oxygen Toxicity* (ACOT), or *Carbon monoxide or Carbon dioxide poisonings* (CMI or CDI), in the relation to which the word **Intoxication** should be preferred over *Poisoning* because its initial coincides with its translation into the majority of European languages,

In the **gas volume dependent** subgroup, the reduction of gas volume during the compression phase, is the cause of **iM**plosive traumatism; the contrary effect during decompression produces **eX**plosive barotraumatism. When this phenomenon occurs within the chest, the first part of the **Intrathoracic Hyperpressive Syndrome** (IHS) appears, although not always the intrathoracic hyperpressurized air enters into the blood stream, so it is a non-bubble-related disorder yet.

Other group of Dysbaric disorders are **BUBBLE-RELATED** (Code: **B**). Decompressive bubbles remain intratisular, interstitial or extravascular causing by Infiltration compressive or ischaemic effects that will produce varied clinical forms of DCS, some of which were included in the old type I group. In some southern European areas, divers and also some physicians, usually apply the name "*embolia*" to all kind of decompression signs/symptoms, even limb bends; on the contrary, in some anglosaxon areas the term "*neurological, cerebral or vestibular bends*" are sometimes employed. If, perhaps, we are obliged, by history and by tradition, to continue using this inadequate and medically inexpressive word, the term *bends* should be only applied to the bubble-related infiltrative non-embolic limb pain, and *embolism* should not be applied to the infiltrative/ischaemic bubble-related decompressive minor incidents.

Bubbles will enter into the blood stream producing gas Embolism of arterial or venous vessels; this implies not only an etiopathogenic but an important clinical difference. The air bubbles released from a hyperpressurized chest will enter into the **Arterial** system and this will define the predominant encephalic extension of the disease, although other areas can also be embolized.

Bubbles formed in tissues are drained through the **Venous** system and for years this was considered the only mechanism of decompression sickness. It has been proved that arterial embolization is almost always present in DCS, although it can be difficult to detect. This group of embolizing disorders is actually mixed, which means mainly venous plus arterial, and target organs are the spinal cord, the inner ear and the brain.

Other group of dysbaric bubble-related disorders do not depend, or do not only depend, on their infiltration in tissues or on their embolizing action, but on the haemodynamic and rheological alterations developed over the plasm/bubble interphase causing a real **Systemic** disease. Depending on the importance of these mechanisms, the patient can be in a very specific and peculiar kind of shock. It is not a cardiogenic shock, in spite of the fact that some of its required factors have been developed; it is not a pure neurogenic, shock although the clinical presentation may be really similar; it is strictly not a hypovolemic shock since no blood lack has occurred, although haemoconcentration due to hypovolemia sometimes reaches in DCS the highest value that can be seen in human pathology. It is a new type of shock, different, specific, characteristic, that we can properly qualify as **DYSBARIC SHOCK**.

#### 4.- **CHRONOLOGICAL CLASSIFICATION**

According to the phase of the immersion in which the accident has happened, five different situations may be differentiated (Table 8). The non-dysbaric diving disorders can happen in the surface or **at any moment** while in the water. Implosive barotraumatism, for instance, are

**compressive/descent** disorders. Non-bubble-related gas-solution-dependent disorders are developed during the underwater **stay at depth**. Bubble-related infiltrative/ischaemic, and embolizing accidents are initiated **during the ascent** and they continue during the first hours after surfacing. Systemic signs or symptoms are mainly prominent after surfacing. Dysbaric osteonecrosis and other long term effects of diving are post-dive or **after-surfacing** diving disorders.

## 5.- EVOLUTIONAL CLASSIFICATION

Diving Disorders can be finally classified according to their outcome and clinical evolution (Table 9). The majority of dysbaric disorders are **acute** in the strict sense of this word. Some divers may follow a **relapsing** outcome. Some rare forms experience a **recurrent** evolution. Some few disorders, like Dysbaric osteonecrosis (DON), can be considered as **chronic**.

## SIMPLIFIED CLASSIFICATION

If all these different groups are placed in one single table that includes all diving disorders, the result can be discouraging (Table 10). Obviously this extended classification, although being very flexible, is not immediately easy to use and require some reflection, a good analysis of the actual condition of the patient, and a good knowledge of dysbaric/diving physiology. For general practice, and for the majority of situations common in medical centres, such deep description is not necessary. For those routine cases we have developed a last synthesizing classification (Table 11). It will bring together, in one single group, the few major factors, syndromes, and pathogenic mechanisms, that must be noted when dealing with a diver who has suffered a diving disorder, because they condition not only some parts of the treatment, but even the final prognosis of the disease. Abbreviations are the same as already explained.

## FINAL REMARKS

As the final part of this preliminary report we have applied this classification to those situations defined in Table 2 as commonly seen in injured divers, in order to verify its utility and practice. These cases are explained in the pages that follow. On the right of the last line of any case the corresponding alpha-numeric code is annotated. We suggest that readers use these examples trying to establish the utility, or not, of this approach to descriptively classify Diving Disorders.

Obviously we are not only fully opened to accept all kind of comments and constructive criticisms, but we actually will appreciate receiving your suggestions in order to improve this classification. You will decide if it can be useful for our common purpose.

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TABLE 1

**MOST COMMON SIGNS/SYMPTOMS  
OF DYSBARIC DISORDERS**

SIGN/SYMPTOM	%
Limb bends	31.20
Vertigo	20.90
Paraparesis	19.30
Consciousness alteration	14.50
Bladder paralysis	13.80
Skin rash	12.50
Monoparesis	10.00
Lumbar pain	8.00
Bronchoaspiration	5.10
Paraplegia	5.10
Subcutaneous emphysema	4.50
Tympanic barotrauma	4.80
Pneumomediastinum	4.50
Hemiparesis	4.80
Haemoptysis	2.90
Rhinolalia	2.60
Shock	2.30
Hemiplegia	1.30
Tetraparesis	1.30
Tetraplegia	1.00
Pneumothorax	1.00
Other signs/symptoms	1.60

(Source : **CRIS** - Unitat de Terapèutica Hiperbàrica - Barcelona)

TABLE 2

## **COMMON CLINICAL MANIFESTATIONS OF DIVING DISORDERS**

Otalgia during immersion  
Frontal headache after diving  
Skin pruriginous rash initiated some minutes after surfacing  
Pain in one arm some minutes after diving  
Limb bends + with skin rash  
Subjective neurological signs/symptoms  
Subjective neurological signs/symptoms + limb pain  
Paraparesis + bladder paralysis  
Paraplegia + haemodynamic/rheological alterations  
Chest pain + cervical emphysema after a rapid ascent  
Hemiparesis after a free ascent  
Hemiplegia + pneumomediastinum + haemodynamic/rheological alterations  
Tetraplegia + thoracic and/or abdominal impairment + dysbaric shock  
Vertigo initiated during ascent  
Vertigo initiated after surfacing

TABLE 3

<b>DIVING DISORDERS Classification Criteria</b>
<ul style="list-style-type: none"><li>● Morphologic</li><li>● Clinic</li><li>● Etiopathogenic</li><li>● Chronologic</li><li>● Evolutional</li></ul>
<ul style="list-style-type: none"><li>● SIMPLIFIED</li></ul>

TABLE 4

<b>MORPHOLOGICAL CLASSIFICATION OF DIVING DISORDERS</b>	<b>Code</b>	<b>Description</b>
<b>Cutaneous</b> Petechial Infiltrative Maculous Emphysematous	(cut)  <i>pet</i> <i>inf</i> <i>mac</i> <i>emp</i>	C.pet C.inf C.mac C.emp
<b>Muscular</b>	<i>mus</i>	
<b>Osteo-articular</b>	<i>ost</i>	
<b>Neurologic</b> Cerebral Cerebellar Medullar Peripheral Neuropsychic	(N)  <i>cer</i> <i>crb</i> <i>med</i> <i>per</i> <i>psy</i>	N.cer N.crb N.med N.per N.psy
<b>Systemic</b> Haemodynamic Rheologic Coagulopathic Dysbaric shock	(S)  <i>hem</i> <i>rhe</i> <i>cgl</i> <i>shk</i>	S.hem S.rhe S.cgl S.shk
<b>Somato-Splanchnic</b> Otologic - <i>Tympanic</i> - <i>Vestibular</i> Sinusal Dental Thoraco-respiratory - <i>Pulmonary</i> - <i>Pleural (pneumothorax)</i> - <i>Mediastinal (pneumomediastinum)</i> Abdomino-gastrointestinal	<i>oto</i>          <i>res</i>	<i>tym</i> <i>ves</i> <i>sin</i> <i>den</i>    <i>pul</i> <i>pnt</i> <i>pnm</i> <i>abd</i>

TABLE 5

<b>CLINICAL CLASSIFICATION OF DIVING DISORDERS</b>	<b>Abbreviation (DD)</b>
Decompression Sickness	DCS
Dysbaric Osteonecrosis	DON
Intrathoracic Hyperpressive Syndrome <ul style="list-style-type: none"> <li>- <i>Thoraco-pulmonary syndrome</i></li> <li>- <i>Abdomino-gastrointestinal barotraumatism</i></li> <li>- <i>Arterial Gas Embolism</i></li> <li>- <i>Systemic syndrome</i></li> </ul>	IHS TPS AB AGE SS
Inert gas narcosis High Pressure Neurologic Syndrome	IGN HPNS
ENT Barotraumatism	ENTBT or ORLBT
Breath-hold anoxic syncope of emersion Extreme depth apnoeic pulmonary oedema	BASE EDAPO or EDAPE

TABLE 6 - Etiopathogenic Classification of Diving Disorders – I

<b>NON-DYSBARIC Diving Disorders</b>	<b>Code</b>	<b>Description</b>
<p><b>Traumatic</b></p> <p><i>Aquatic animals injury</i>  <i>Static jolt or impact</i>  <i>Diving systems caused damage</i></p>	R	DØR
<p><b>Adaptative</b></p> <p><i>Hypothermia</i>  <i>Thermo-differential shock</i>  <i>Kinetosis</i></p>	P	DØP
<p><b>Coincidental</b></p> <p>Pre-existent silent diseases  <i>Seizures</i>  <i>Hypoglycaemia</i>  <i>Asthma attack</i>  <i>Cardiac attack</i></p> <p>Unknown or hidden  <i>Loss of consciousness</i>  <i>Any disorder causing drowning</i></p>	C	DØC



TABLE 8

## CHRONOLOGICAL CLASSIFICATION OF DIVING DISORDERS

### In the surface (and/or at any moment while in the water)

*Aquatic animals injury*  
*Static jolt or impact*  
*Diving systems damage*  
*Hypothermia*  
*Thermo-differential shock*  
*Kinetosis*  
*Seizures*  
*Hypoglycaemia*  
*Asthma attack*  
*Cardiac attack*  
*Loss of consciousness*  
*Any disorder causing drowning*

### During descent / compression

**Implosive** barotraumatism  
*Squeeze*  
*Dental*  
*Tympanic and sinusal*  
*Oval and round window*  
*Pulmonary*

### During stay at depth

Inert gas narcosis (IGN)  
 High Pressure Neurologic Syndrome (HPNS)  
 Extreme depth apnoeic pulmonary oedema (EDAPE)

### During ascent / decompression

**Explosive** barotraumatism  
*Dental*  
*Sinusal and tympanic*  
*Alternobaric vertigo*  
*Gastro-intestinal*  
*Intrathoracic Hyperpressive Syndrome (IHS)*  
 Decompression Sickness (DCS)  
 Breath-hold anoxic syncope of emersion (BASE)

### After surfacing

Decompression sickness (DCS)  
 Dysbaric Osteonecrosis (OND)  
 Neurological sequels of DCS or IHS  
 Long term effects of diving



TABLE 9

## **EVOLUTIONAL CLASSIFICATION OF DIVING DISORDERS**

- Acute
- Relapsing
- Recurrent
- Chronic or Long Term

TABLE 10

<b>CLASSIFICATION OF DIVING DISORDERS</b>	<b>Code (Abbrev)</b>	<b>Description</b>
<b>NON DYSBARIC</b>	DØ	DØ
<b>Traumatic</b> <i>Aquatic animals injury</i> <i>Static jolt or impact</i> <i>Diving systems caused damage</i>	R	DØR
<b>Adaptative</b> <i>Hypothermia</i> <i>Thermo-differential shock</i> <i>Kinetosis</i>	P	DØP
<b>Coincidental</b> - <b>Pre-existent silent diseases</b> <i>Seizures</i> <i>Hypoglycaemia</i> <i>Asthma attack</i> <i>Heart attack</i> - <b>Unknown or hidden</b> <i>Loss of consciousness</i> <i>Any disorder causing drowning</i>	C	DØC
<b>DYSBARIC</b>	D	D
<b>Non-bubble-related or Non-bubble-forming</b>	BØ	DBØ
<b>Gas Solution Dependent</b> <i>Breath-hold anoxic syncope of emersion</i> <i>Extreme depth apnoeic pulmonary oedema</i> <i>Inert gas narcosis</i> <i>High pressure neurologic syndrome</i> <i>Acute oxygen cerebral toxicity</i> <i>Carbon monoxide intoxication</i> <i>Carbon dioxide intoxication</i>	L BASE EDAPE IGN HPNS ACOT CMI CDI	DBØL
<b>Gas Volume Dependent</b> (Barotraumatism) ▪ <b>IMPLOSIVE</b> <i>Squeeze</i> <i>Dental</i> <i>Sinusal</i> <i>Tympanic</i> <i>Oval and round window</i>  ▪ <b>EXPLOSIVE</b> <i>Dental</i> <i>Sinusal</i> <i>Tympanic</i> <i>Alternobaric vertigo</i> <i>Gastro-intestinal</i> <i>Respiratory or Thoraco-pulmonary</i> <i>Cutaneous</i> <i>Pleural</i> <i>Mediastinal</i> <i>Pulmonary</i>	M <i>squ</i> <i>den</i> <i>sin</i> <i>tym</i> <i>win</i>  X <i>den</i> <i>sin</i> <i>tym</i> <i>alt</i> <i>int</i> <i>res</i> <i>cut</i> <i>pnt</i> <i>pnm</i> <i>pul</i>	DBØM DBØM.squ DBØM.den DBØM.sin DBØM.tym DBØM.win  DBØX DBØX.den DBØX.sin DBØX.tym DBØX.alt DBØX.int DBØX.res DBØX.cut DBØX.pnt DBØX.pnm DBØX.pul
<b>Bubble-related or Bubble-forming</b> (Combined, solution and volume dependent)	B	DB
<b>Infiltrative/ischaemic</b> (extravascular or intratissular bubbles) <i>Cutaneous</i> <i>Muscular</i> <i>Osteo-articular</i> <i>Neural</i>	I <i>cut</i> <i>mus</i> <i>ost</i> <i>neu</i>	DBI DBI.cut DBI.mus DBI.ost DBI.neu
<b>Embolic</b> (gas embolism) ▪ <b>ARTERIAL</b> (due to pulmonary gas explosion) <i>Encephalic</i> <i>Cerebral</i> <i>Cerebellar</i> <i>Coronanic</i>  ▪ <b>VENOUS</b> (mainly) + arterial (due to tissue gas saturation) <i>Medullar</i> <i>Vestibular</i> <i>Cerebral</i> <i>Cerebellar</i>	A  <i>cer</i> <i>crb</i> <i>cor</i>  V <i>med</i> <i>ves</i> <i>cer</i> <i>crb</i>	DBA  DBA.cer DBA.crb DBA.cor  DBV DBV.med DBV.ves DBV.cer DBV.crb
<b>Systemic</b> (due to gas-liquid interphase interaction) <b>HAEMODYNAMIC</b> <i>Hypovolemia</i> <i>Haemoconcentration</i> <i>Dysbaric shock</i>  <b>RHEOLOGIC</b> <i>Consumptive coagulopathy</i> <i>Disseminate Intravascular Coagulation</i>	S <i>hem</i>   <i>shk</i> <i>rhe</i> <i>cgl</i> <i>dic</i>	DBS DBS.hem   DBS.shk DBS.rhe DBS.cgl DBS.dic

TABLE 11

SIMPLIFIED CLASSIFICATION of Diving Disorders	Abbreviation
<b>NON-DYSBARIC DIVING DISORDERS</b>	NDDD
<p><b>DYSBARIC DISORDERS</b></p> <p><b>Non-embolizing or non-bubble-related</b></p> <ul style="list-style-type: none"> <li>- <b>Gas Solution Dependent</b> :           <ul style="list-style-type: none"> <li>Breath-hold anoxic syncope of emersion</li> <li>Inert gas narcosis</li> <li>Acute Cerebral Oxygen Toxicity</li> <li>Carbon monoxide intoxication</li> <li>Carbon dioxide intoxication</li> </ul> </li> <li>- <b>Gas Volume Dependent - Barotrauma</b> <ul style="list-style-type: none"> <li><b>IMPLOSIVE</b> (of the descent) :               <ul style="list-style-type: none"> <li>Sinusal</li> <li>Medium ear</li> <li>Inner ear</li> </ul> </li> <li><b>EXPLOSIVE</b> (of the ascent) :               <ul style="list-style-type: none"> <li>Sinusal</li> <li>Tympanic (few frequent)</li> <li>Alternobaric vertigo</li> </ul> </li> </ul> </li> </ul>	<p>DD</p> <p>BASE</p> <p>IGN</p> <p>ACOT</p> <p>CMI</p> <p>CDI</p>
<p>Thoraco-pulmonary</p> <p><b>Bubble-related</b></p> <ul style="list-style-type: none"> <li>- <b>Arterial Gas Embolism</b></li> </ul>	<p>Intrathoracic Hyperpressive Syndrome IHS</p>
<ul style="list-style-type: none"> <li>- <b>Mixed venous (mainly) + arterial</b> embolizing bubbles: <i>medullar, cerebral, vestibular</i></li> <li>- <b>Infiltrative/ischaemic</b> (extravascular bubbles): <i>cutaneous, muscular, neural</i></li> <li>- <b>Systemic</b> (due to the bubble gas/liquid interphase interaction): <i>dysbaric shock</i></li> </ul>	<p>Decompression Sickness DCS</p>

## New descriptive Classification of Diving Disorders

### EXAMPLES

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#### **Otalgia during immersion.**

*Dysbaric, non-bubble-related, implosive, otologic.*

Tympanic barotrauma

Descent - Acute

**DBØM.oto**

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#### **Frontal headache after diving.**

*Dysbaric, non-bubble-related, explosive, sinusal.*

Sinusal barotrauma

Ascent - Acute

**DBØX.sin**

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#### **Skin pruriginous rash initiated 45 minutes after surfacing.**

*Dysbaric, bubble-related, infiltrative, cutaneous, (petechial, infiltrative, maculous, or emphysematous).*

Cutaneous Decompression Sickness (old type I)

Ascent - Acute

**DBcut (pet,inf,mac, or emp)**

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#### **Pain in one arm 15 minutes after diving.**

*Dysbaric, bubble-related, infiltrative, muscular.*

Muscular Decompression Sickness

Ascent - Acute

**DBI.mus**

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#### **Limb pain + with small non-confluent haemorrhagic skin lesions.**

*Dysbaric, bubble-related, infiltrative, muscular and cutaneous.*

Cutaneous and muscular Decompression Sickness

Ascent - Acute

**DBI.mus.cut.pet**

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#### **Subjective neurological signs/symptoms in one arm.**

*Dysbaric, bubble-related, infiltrative-ischæmic, neurological, peripheral.*

Neurel (or peripheral neurologic) Decompression Sickness

Ascent - Acute

**DBI.neu**

**Subjective neurological signs/symptoms + limb pain.**

*Dysbaric, bubble-related, infiltrative-ischaemic, neurologic, peripheral, and muscular.*

Muscular and neural (or peripheral neurologic) Decompression Sickness

Ascent - Acute

**DBI.neu.mus**

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**Paraparesis + bladder paralysis.**

*Dysbaric, bubble-related, venous embolizing, neurologic, medullar.*

Medullar neurologic Decompression Sickness

Ascent - Acute

**DBV.med**

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**Paraplegia + dysbaric shock.**

*Dysbaric, bubble-related, venous embolizing, neurologic, medullar, systemic.*

Medullar neurologic and systemic Decompression Sickness

Ascent - Acute

**DBV.med.S**

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**Chest pain + cervical emphysema after a rapid ascent.**

*Dysbaric, non-bubble-related, explosive, thoracic and cutaneous.*

Pulmonary barotrauma due to Intrathoracic Hyperpressive Syndrome

Ascent - Acute

**DBØX.pul.cut.emp**

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**Hemiparesis after a free ascent.**

*Dysbaric, bubble-related, arterial embolizing, neurologic, cerebral.*

Arterial cerebral gas embolism due to Intrathoracic Hyperpressive Syndrome

Ascent - Acute

**DBA.cer**

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**Hemiplegia + pneumomediastinum + dysbaric shock.**

*Dysbaric, bubble-related, arterial embolizing, neurologic, cerebral, systemic, and explosive, thoracic.*

Arterial cerebral gas embolism and pleuro-pulmonary barotrauma due to Intrathoracic Hyperpressive Syndrome

Ascent - Acute

**DBA.cer.SXT**

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**Tetraplegia + dysbaric shock + gastric distension + pneumothorax + pneumoperitoneum, after a free ascent from deep and long dive.**

*Dysbaric, bubble-related, arterial and venous embolizing, neurologic, cerebral and medullar, systemic, explosive, pulmonary, and abdominal.*

Arterial and venous cerebral and medullar gas embolism, pleuro-pulmonary and gastrointestinal barotrauma due to both Decompression Sickness and Intrathoracic Hyperpressive Syndrome

Ascent - Acute

**DBAV.cer.med.SX.pul.abd**

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**Vertigo with facial pain initiated during ascent from a short and shallow dive.**

*Dysbaric, non-bubble-related, explosive, otological.*

Alternobaric vertigo

Ascent - Acute

**DBØX.oto**

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**Vertigo initiated five minutes after surfacing from a long and deep immersion with normal ascent and correct ears equalization, and no other neurological impairment.**

*Dysbaric, bubble-related, venous-combined embolizing, vestibular.*

Vestibular Decompression Sickness

Ascent - Acute

**DBV.ves**

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Barcelona, March 1996