

Goodbye Decompression Sickness. Hello Disorders:

A New approach To Classification

by T.J.R. Francis, D.J. Smith and J.J. W. Sykes, Institute of Naval Medicine, Hampshire, England. The current means by which we classify decompression sickness dates back only 30 years to the experience gained during the construction of the Dartford Tunnel in London. Golding *et al* [1] proposed a system for decompression sickness based upon perceived severity of the cases which arose in the caisson workers employed in the construction of the tunnel. Only symptoms considered sufficiently severe to bring the man [sic] back for treatment were considered to be decompression sickness. They divided the cases into two types: Type I, or simple 'bends' and Type II, which were more serious or complicated cases which displayed vertigo, shock, paralysis, epigastric pain and shortness of breath. Their system is still in use today essentially unchanged. Traditionally, decompression sickness has been distinguished from the barotraumatia and a summary of the current classification of the decompression disorders is presented in Table 1.

T.1: Traditional Decompression Sickness Terminology

This classification [4] requires the diagnostician to make difficult decisions, particularly where the nervous system is involved. These include determining the location of the lesion (e.g. "cerebral" or "spinal cord") and the mechanism of injury (e.g. "decompression sickness" or "arterial gas embolism"). At a 1991 Undersea and Hyperbaric Medical Society workshop [5] it was recognized that in the great majority of clinical settings, and certainly in the field, such decisions are virtually impossible to make with certainty. Consequently, existing diagnostic "labels" cannot be applied rigorously. As a result, treatment algorithms are inconsistently applied and communication between divers, physicians and medical researchers is compromised.

The existing dichotomy between "Type I" or mild decompression sickness (DCS) and "Type II," or serious DCS, is spurious. Each group contains a variety of conditions with no known commonality of pathophysiology. It is widely recognized that symptoms from the two categories may coexist and that "Type I" may progress to "Type II." *Consequently, the use of these terms is not just confusing, but potentially dangerous if divers are lulled into delaying or failing to report a symptom as a result of using terms such as "pain-only," "mild," "non-serious," or "Type I."* These terms also lack any inherent meaning, they have to be learned. Consequently, communication with medical personnel who have not been indoctrinated into their use is difficult. Decompression disorders are potentially highly dynamic conditions, yet the terminology currently used takes no account of this. This dynamic quality (e.g. progressive or relapsing) maybe a better index of the urgency of a case than whether it is "Type I" or "Type II."

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The main reason why the existing classification has been retained is that its use has been made seductive. Treatment tables have been applied, more or less as a reflex, depending upon whether the "diagnosis" is "Type I," "Type II," or "AGE" (arterial gas embolism). Fitness to return to diving (or aviation) has been based upon the same, arbitrary, diagnostic categories. *This has resulted in patients being shoe-horned, occasionally with much difficulty, into these artificial and very limited groups more for administrative convenience than as a true reflection of what is wrong with the patient.*

It was concluded at this workshop, that the present system of classification based on medical cause should be abandoned and that a descriptive definition of the decompression disorders be adopted. The workshop proposed that the current terms: Decompression sickness 'Type I,' 'Type II' and Arterial Gas Embolism

be abandoned in favor of the term "Decompression Illness," or DCI, which, for terminology purposes, is modulated by terms that describe the evolution and manifestations of the disease.

The protocol consists of a matrix which provides a formalized *aide memoir* for data collection and from which a terminology has been derived that can be used to describe a wide variety of decompression conditions. The following key information is required to describe a case of decompression illness adequately: the evolution of the case; clinical manifestation(s); the time to onset of each manifestation; the gas burden and whether there is evidence of barotrauma. Additional important information includes: the response to recompression and the results of any investigations. A summary of this system is in Table 2 and definitions are provided below.

T.2: Descriptive Definition of Decompression Disorders

Evolution of DCI

The evolution of a case refers to the development of the condition *prior to recompression*. This information is best recorded as the case evolves. Because DCI is frequently dynamic, the evolution may change from one observation to the next. Thus, a condition that initially presents as being "*progressive*," as the patient becomes increasingly aware that something is wrong, may stabilize so that it can then be described as "*static*." The patient may subsequently undergo a substantial improvement, occasionally to the extent of a complete resolution of symptoms. This can be described as "*spontaneously improving*." Occasionally, the symptoms return or new symptoms appear, in which case the condition would be described as "*relapsing*."

A condition may be described as *progressive* if the number or severity of symptoms or signs increases—e.g. limb pain that becomes increasingly severe, or involves more sites, or a neurological presentation in which the loss of function becomes more profound or extensive. The development of a new manifestation, such as a neurological symptom or sign in addition to limb pain, also represents progression of the condition. Additional description may also be useful such as whether the progression is rapid or slow.

If the condition is not changing substantially, it is *static*.

It is common for a number of presentations of DCI to improve without recompression. Sometimes this may be to the point of apparent recovery, although this may only be transient. Because the intensity of DCI symptoms can fluctuate, substantial improvement must occur to apply the term *spontaneous improvement*. As with other terms describing a case's evolution, this should only be used to describe events prior to recompression.

Occasionally, cases that have improved spontaneously undergo a secondary deterioration, or relapse, particularly with some neurological manifestations. When a condition gets worse in the absence of any spontaneous improvement, it should be described as *progressive*.

DCI Manifestations

Pain is probably the most frequent manifestation of decompression illness. It describes the deep aching pain in or around one or more joints which may begin during decompression or after completion of a dive. Unlike the pain of musculoskeletal injury, limb pain decompression illness is generally not exacerbated by movement of the affected joint. The pain may range from mild, barely detectable discomfort to a steady, boring, nearly unbearable pain. Limb pain should be distinguished from "girdle pain." This is a poorly localized, aching or "constricting" sensation which is generally in the abdomen, pelvis or, occasionally, in the chest. Girdle pain in the context of decompression illness is generally considered ominous since it is frequently a harbinger of neurological deterioration.

Involvement of the nervous system may be subtle, multi-focal and very difficult to localize. A number of different mechanisms may be involved in the development of the pathology of these neurological conditions, so it is important that the terminology presumes neither a location or a mechanism.

Neurological involvement can be broken down into the loss of certain functions: higher functions, which would include aberration of thought processes or affect, loss of memory, difficulty talking etc.; alteration to the level of consciousness, including seizures; loss of coordination, strength or sensation; dysfunction of special senses; loss of bladder control or anal function.

Involvement of the audio-vestibular system is a distinct syndrome within the neurological category that consists of vertigo, tinnitus (ringing in the ears), nystagmus (jerking movements of the eyes) and loss of hearing after a dive. Nausea and vomiting may accompany these symptoms but, of themselves, are not sufficient to imply audiovestibular involvement. Again, more than one mechanism may be responsible for this manifestation, and it may be very difficult, without elaborate investigation, to determine the site of injury. However, if a cause can be established, such as round window fistula (?????? **HELP**), then the more specific diagnosis should be made.

Pulmonary involvement in DCI may be resultant of two quite distinct processes: lung rupture due to barotrauma and the cardiopulmonary consequences of massive venous gas embolism. Although the mechanisms involved are distinctly different, it may be difficult for lay personnel to distinguish between them initially, because many of the symptoms and signs are shared. However, modern diving practices result in pulmonary DCI due to the latter mechanism very rarely indeed. The symptoms or signs that imply pulmonary involvement in decompression illness include chest pain, cough, haemoptysis (coughing up blood or blood-stained sputum), shortness of breath, cyanosis (blueness or duskiness of the skin, lips or mucuous membranes), pneumothorax (gas trapped in the pleural space in the chest), subcutaneous emphysema ("crackling" under the skin) of the neck and, occasionally, voice change. When describing pulmonary decompression illness, it is important to note whether clinical or radiological evidence of pneumothorax or mediastinal emphysems exists as this is known to be a consequence of lung rupture. The skin may be affected by diving in a number of ways. Two very common manifestations of decompression, which are not generally regarded as illnesses, are suit "squeeze" and itching in the absence of a rash. The term cutaneous DCI should be used to describe the condition that generally presents with severe itching around the shoulders or over the trunk which, after a time, develops into an erythematous rash and which may progress to blue-ish mottling or marbling of the skin. When further describing the condition, it is desirable to describe the location of the disorder.

Lymphatic DCI may be used to describe cases in which there is painful swelling of individual or discrete groups of lymph nodes or rare cases where there is extensive edema of one or more limbs.

A number of non-specific symptoms can occur after diving which, if severe or if accompanied by other manifestations, may be considered part of the DCI syndrome. These constitutional symptoms include headache, fatigue, malaise (which may include nausea and vomiting) and lack of appetite.

Very rarely, other manifestations of decompression illness may occur. Such conditions should be described using appropriate medical terminology.

Other Significant Data

The time of onset can provide a great deal of information to medical personnel regarding mechanisms of disease and, possibly, the outcome of some cases. Following hyperbaric exposures, this should be the time from reaching the surface to the onset of the manifestation. If the manifestation occurs during ascent it should be recorded as such.

The gas burden is an estimate of the residual inert gas load present on surfacing. At present, recording the dive profile is the most useful index available.

Clinical or radiographic evidence of barotrauma should be documented, particularly where there are pulmonary or audiovestibular manifestations. Where there is such evidence, the barotraumatata are diagnosed as before.

To complete an accident record, it is important to record the outcome of recompression and the results of additional clinical investigations.

The Language of DCI

Lengthy descriptions are unwieldy for communication purposes, and an abbreviated label is needed until the natural syndromes are identified. The proposed new form for describing a decompression disorder is as follows (see T.2):

Acute, [Evolution Term], [Manifestation Term(s)], Decompression Illness

In this case, the term "acute" distinguishes the conditions described above from the possible chronic consequences of decompression, such as osteonecrosis (bone necrosis). The phrase decompression illness (DCI) incorporates the familiar terms decompression sickness and arterial gas embolism. The appropriate evolution term, is used exactly as defined above. The number of manifestation terms which are used will depend both on the condition and the context in which the terminology is employed (see T.2). In a condition with only one or two manifestations, it is appropriate to use those that apply, for example, "acute static, cutaneous and neurological decompression illness." In complex cases it may be appropriate to use the term "multisystem."

The amount of detail in the description depends on the purpose for which the terminology is being used. As a diagnostic label, the above terminology should suffice. Frequently more information is needed, such as during the transmission of information over the telephone or radio during a consultation. In this situation, the three additional key pieces of information—the time on onset, the gas burden, and any evidence of barotrauma—can be added. These are likely to be valuable in discriminating between the various syndromes. An example of such a brief report is:

"Acute progressive limb pain and neurological decompression illness presenting 20 minutes after surfacing with a moderate gas burden and no evidence of barotrauma."

For treatment reports and database purposes a more detailed report is likely to be necessary.

The main advantage of this system is that it contains no guesswork with respect to either the mechanism or the anatomical location of the disease process. Furthermore, it employs terms that are readily understood within the medical community. It does not require that the first person to attend the patient have a great deal of experience or expertise to use it properly. Communication between divers and non-diving medical personnel will be facilitated by its use, because all the terms have inherent meaning.

However, basic instruction is critical for the system to be used properly. Such instruction is made relatively simple because there is no need to brain wash people to accept untenable rules and assumptions. This system permits the description of a dynamic, changing condition without difficulty.

The main advantage of this system is that it contains no guesswork with respect to either the mechanism or the anatomical location of the disease process. Furthermore, it employs terms that are readily understood within the medical community. It does not require that the first person to attend the patient have a great deal of experience or expertise to use it properly.

We have been unable to classify decompression illness reliably to date, which has limited our progress towards understanding these intriguing conditions. It is hoped that by using a readily understood descriptive terminology, consistent and accurate 'diagnoses' should now be possible, which will improve the management of cases. More importantly, if these data are then collected and collated, the natural syndromes associated with decompression will become readily apparent. If we learn what the natural syndromes are, we will be able to direct our efforts more effectively towards preventing decompression illness more effectively in the future.

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