Decompression Illness Diagnosis and Decompression Study Design

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THE RECENT ARTICLE, "Decompression Illness Reported in a Survey of 429 Recreational Divers," by Klingmann et al. (9) illustrates a common problem in decompression studies, the diagnosis of decompression illness (DCI). DCI includes decompression sickness (DCS) and arterial gas embolism (AGE) and is characterized by manifestations that can have causes unrelated to decompression (5). Even though DCI experts tend to employ similar diagnostic criteria (6), the diagnosis of DCI is challenging because there are no specific diagnostic tests. Lack of diagnostic certainty is not necessarily a clinical problem since divers with suspected DCI are usually recompressed when a chamber is available in the absence of medical contraindications. However, valid research requires that misdiagnosis be minimized, and operational definitions are the best alternative for this purpose. We suggest that clinicians document cases and investigators formulate operational definitions based on the following factors:

1. Minimum exposure. As divers' memories are often inaccurate, use a dive computer recorded depth-time profile, if possible. Select a minimum depth-time exposure for DCS. For example, DCS is unlikely after a single dive at depths shallower than 30 fsw (9 msw) (13) and virtually impossible at depths shallower than 20 fsw (12). A more conservative measure of exposure would be half the U.S. Navy no-stop limits, although this is not so useful for repetitive dives, which are common (7).
2. Symptom onset time. Rapid onset (< 15 min after surfacing) of cerebral signs or symptoms is considered characteristic of AGE. Supporting evidence includes rapid or panic ascent and evidence of pulmonary barotrauma. Onset of DCS signs and symptoms may also occur early (including during ascent), most within 6 h. Symptoms that develop after a delay of 24 h or more are less likely to be DCI unless there was a second decompression such as in flying or mountain travel.
3. Differential diagnosis. DCI is characterized by pain (usually without physical signs of inflammation or physical injury), skin rash or swelling, and/or a wide range of neurological signs and symptoms that start within 24 h of a dive. Mild DCI symptoms (limb pain, constitutional symptoms, nondermatomal paresthesias without objective neurological signs, or skin rash) almost invariably stabilize within 24 h unless there is repetitive decompression (including altitude exposure) and do not worsen over days, weeks, or months (11). Chronic, evolving, nonspecific symptoms (e.g., headache) or clearly atypical symptoms (e.g., diarrhea) should not be used as the sole basis for assigning a diagnosis of DCI. Drug effects (e.g., starting a new drug or stopping a previously taken drug), toxins (e.g., carbon monoxide, ciguatera), envenomation, and neurological conditions with coincidental onset shortly after a dive (e.g., stroke, seizure, multiple sclerosis) can produce manifestations similar to DCI.
4. AGE versus DCS. It is important to distinguish AGE from DCS for cases used to design or test decompression procedures. (AGE and DCS may occasionally occur simultaneously.) AGE usually occurs after a breath hold or fast ascent and is associated with rapid onset of cerebral manifestations including impaired consciousness, aphasia, visual loss, diplopia, vertigo, hemiparesis/sensory signs, or affective/cognitive signs. For DCS, pain, para- or quadraparesis, subjective/objective nondermatomal sensory effects, or urinary retention are more likely. Operational definitions that differentiate AGE from DCS should be reported.
5. Manifestations. Cases should be described with the times of reported and observed signs and symptoms through development and resolution. Residual symptoms after recompression should be followed up to resolution or to stability (e.g., over a 1-yr period) when possible. Rating scales used to quantify severity should be specifically defined (3,10,14). "Accepted" rating scales (e.g., "Type 1", "Type 2" DCS) are defined inconsistently, are too broad (especially "Type 2" DCS), and are not recommended.
6. Treatment response. Rapid response to surface oxygen or recompression is not absolutely diagnostic, but increases confidence in a positive diagnosis. Lack of improvement with timely recompression does not exclude a DCI diagnosis, but decreases the likelihood.

Cases that are suspicious but uncertain should be categorized as ambiguous rather than as DCI.

We do not offer explicit definitions of AGE and DCS and at present recommend classification by manifestations. As others have suggested, the best index by which to assess the effects of dive profile, surface oxygen, time to treatment, treatment type, etc. may be the nature and incidence of short-term and long-term residual manifestations after completion of therapy (1,2,4,8,10).

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