Management of mild or marginal decompression illness in remote locations workshop proceedings

[Final consensus statements, editorial notes and executive summary]
Simon J Mitchell, David J Doolette, Christopher J Wacholz and Richard D Vann (editors)

Final consensus statements

Consensus statement 1

With respect to decompression illness (DCI), the workshop defines “mild” symptoms and signs as follows:

- limb pain
- constitutional symptoms
- some cutaneous sensory changes
- rash

where these manifestations are static or remitting and associated objective neurological dysfunction has been excluded by medical examination.

Footnotes
1 The workshop agrees that severity of pain has little prognostic significance, but acknowledges that severity of pain may influence management decisions independent of the classification of pain as a “mild” symptom.
2 Classical girdle pain syndromes are suggestive of spinal involvement and do not fall under the classification of “limb pain.”
3 The intent of “some cutaneous sensory changes” is to embrace subjective cutaneous sensory phenomena such as paraesthesiae that are present in patchy or non-dermatomal distributions suggestive of non-spinal, non-specific, and benign processes. Subjective sensory changes in clear dermatomal distributions or in certain characteristic patterns such as in both feet, may predict evolution of spinal symptoms and should not be considered “mild.”
4 The proclamation of “mild” cannot be made where symptoms are progressive. If the presentation initially qualifies as mild and then begins to progress, it is no longer classified as “mild” (see also Footnote 5).
5 The possibility of delayed progression is recognised, such that the “mild” designation must be repeatedly reviewed over at least the first 24 hours following diving or the most recent decompression, the latter applying if there has been an ascent to altitude. Management plans should include provisions for such progression.

Consensus statement 2

The workshop accepts that untreated mild symptoms and signs due to DCI are unlikely to progress after 24 hours from the end of diving.

Footnotes
1 Mild symptoms and signs are strictly limited to those defined in Statement 1 and its footnotes.
2 This statement does not hold where there is a further decompression, such as further diving or ascent to altitude, in the presence of mild symptoms.

Consensus statement 3

Level B epidemiological evidence indicates that a delay prior to recompression for a patient with mild DCI is unlikely to be associated with any worsening of long-term outcome.

Footnotes
1 Levels of evidence in American Family Physician [Internet]. [Leawood(KS)]: American Academy of Family Physicians; c2004 [Cited 2004 Dec 6]. Available at: <http://www.aafp.org/x17444.xml>
2 “Mild DCI” is limited to those presentations exhibiting only “mild symptoms and signs” strictly as defined in Statement 1 and footnotes.

Consensus statement 4

The workshop acknowledges that some patients with mild symptoms and signs after diving can be treated adequately without recompression. For those with DCI, recovery may be slower in the absence of recompression.
Footnote
1 The non-specific reference to “mild symptoms and signs after diving” is intentional. It reflects the fact that the manifestations may or may not be the consequence of DCI. The statement suggests that even if they are the result of DCI, full recovery is anticipated irrespective of the use of recompression although resolution may take longer. Importantly, “mild symptoms and signs” are strictly limited to those defined in Statement 1 and footnotes. Where symptoms and signs fall outside the spectrum of manifestations herein defined as “mild,” standard management and therapy is indicated.

Consensus statement 5

The workshop acknowledges that some divers with mild symptoms or signs after diving may be evacuated by commercial airliner to obtain treatment after a surface interval of at least 24 hours, and this is unlikely to be associated with worsening of outcome.

Footnotes
1 “Mild symptoms and signs” are strictly as defined in Statement 1 and footnotes.
2 It should be noted that most favourable experience with commercial airliner evacuations comes from short-haul flights of between 1 and 2 hours’ duration. There is much less experience with longer flights.
3 It was agreed that provision of oxygen in as high an inspired fraction as possible is optimal practice for such evacuations. In addition, the risk of such evacuation will be reduced by pre-flight oxygen breathing.
4 It was emphasised that contact must be established with a receiving unit at the commercial flight destination before the evacuation is initiated.

Editorial notes

Given the title of the workshop and proceedings, the reader who peruses these statements without a full appreciation of the discussion that led to their final wording may be confused by the absence of specific reference to remote locations. During the consensus discussion it became clear that ethical and legal concerns could be minimised if guidelines for important management decisions were applicable irrespective of the patient’s location. Care was taken to make this so, and the consensus statements therefore do not specifically refer to DCI in remote locations. It is acknowledged, however, that the environmental and logistic characteristics of a remote location (such as weather, aircraft availability or material condition) may need to be considered in management decisions in the interests of patient safety, irrespective of the guidelines promulgated here.

The statements are self-explanatory, but the reader should note that some of them are heavily qualified with footnotes. These qualifications are non-negotiable components of the meaning of each statement, and the statements should not be quoted without reference to these footnotes. Of particular importance is the strict definition of mild symptoms and signs in Statement 1 and footnotes. All references to “mild” in the subsequent statements are linked back to this definition. It follows that statements 2–5 should not be quoted without reference to Statement 1.

Statement 4 is perhaps the pivotal outcome of the workshop. Its intent requires contextual explanation so that the concerns and commentary of the workshop participants are accurately reflected. The statement supports a decision not to recompress for mild symptoms and signs (as defined) after diving where, for example, there is suspicion the symptoms may not be caused by DCI, or where there are logistic or safety reasons to avoid evacuation, such as might exist in a remote location. Statement 4 also reflects the workshop consensus that if the symptoms are due to DCI but they fit the “mild” criteria, then medium to long-term disadvantage to the patient is very unlikely if they are not recompressed. This is clearly quite different from a directive that “henceforth, all cases of mild DCI do not require recompression.” Statement 4 should not be interpreted in this way. Statement 4 merely notes that some patients are unlikely to be disadvantaged by not being recompressed and provides the treating clinician with options for sensible decision making according to the prevailing circumstances. The word “some” is used intentionally to indicate that it is the clinician’s final decision whom to recompress or not. The statement cannot be generalised to allow treatment funding providers to make funding policy decisions about recompression for all mild DCI.

A statement acknowledging the practice of in-water recompression was discussed but not included in the proceedings. The rationale for this deletion was the primary workshop focus on mild DCI. In view of the earlier determinations, especially Statement 4, in-water recompression was not an option likely to be pursued for patients whose presentation met the criteria for “mild” DCI signs and symptoms. In-water recompression was endorsed as an option for severe remote DCI management during the evolving clinical problem evolution (see hypothetic problem discussion), but no policy statements were generated. Its deletion from the consensus statements should not be interpreted as rejection of its utility. The reader is referred to the proceedings of the UHMS in-water recompression workshop for more information.

Statement 4 should not be interpreted as rejection of its utility. The reader is referred to the proceedings of the UHMS in-water recompression workshop for more information.
Similarly, an attempt to provide a consensus statement describing an appropriate time interval between recompression for DCI and flying, usually for the purposes of returning home, was rejected due to insufficient data. There was general agreement that more work is needed in this area.

Reference


Executive summary

David J Doolette, PhD, Department of Anaesthesia and Intensive Care, University of Adelaide, Adelaide, Australia

Decompression illness (DCI) results from the formation of bubbles in body tissues during reduction in ambient pressure. Bubbles can affect any organ system, and DCI may be diagnosed following the onset of one or more characteristic manifestations following a compressed gas dive. Severe manifestations of DCI typically develop rapidly following diving and include central neurological symptoms and signs and, more rarely, cardiopulmonary collapse. The nature and latency of mild symptoms of DCI are more variable. Typical symptoms are limb pain, constitutional symptoms, rash and sensory changes without central neurological manifestations. Since bubbles can be detected in the blood following most dives, and since divers frequently experience vague symptoms following diving, the boundary between “mild DCI” and “no disease” is indistinct.

First-aid treatment for DCI centres on oxygen breathing to accelerate the washout of other gases from bubbles and tissues. Definitive treatment of DCI is recompression to reduce the size of bubbles, with hyperbaric oxygen breathing to accelerate the washout of other gases. Hyperbaric oxygen also has therapeutic actions independent of bubble resolution. Recompression therapy is particularly efficient when administered within minutes following diving; presumably early bubble dissolution limits pathophysiology. Even if recompression is not immediately available, it is self-evident that delay should be minimised for central nervous system DCI and additional decompression (such as by unpressurised air flight) should be avoided during transport to recompression facilities. This viewpoint has guided the management of DCI of all severities for nearly a century.

The purpose of this workshop was to evaluate the precept of urgent, pressurised evacuation for recompression in the context of mild symptoms of DCI and recreational divers amongst whom delay to recompression is typically greater than 20 hours. This was motivated by the increasing popularity of recreational diving in remote locations where even emergency air evacuation to recompression facilities will take many hours. The only present source of data is from retrospective analysis of databases containing cases of mild DCI where treatment has been delayed. Analysis of such Level B1 evidence (epidemiological data not derived from high-quality randomised controlled trials or systematic reviews) risks biased estimates of prognosis or effect of interventions. Specific difficulties with these databases are that they are likely contaminated with non-cases owing to the diagnostic ambiguity for mild DCI and the only outcome measure is the presence or absence of residual symptoms following treatment.

Mild symptoms of DCI that are static or remitting at 24 hours after diving are unlikely to progress to serious symptoms. No incidents of such deterioration were found in databases from several large treatment centres and several recreational and naval databases. Also, divers often do not seek treatment for mild symptoms, and there is no evidence of consequent long-term health problems in the recreational diving population.

The existing literature is divided on whether delay to recompression for DCI influences the treatment outcome, and some of this ambiguity is due to an interaction of disease severity and urgency. However, for mild symptoms of DCI, delay does not appear to influence long-term outcome. Careful filtering to remove doubtful diagnosis from DAN data (1987–97) revealed that delays longer than 12 hours resulted in 5.9 per cent incidence of residual symptoms at the end of all recompressions compared to 3.9 per cent for shorter delays. Delay was a less potent predictor of outcome than other factors (e.g., age), and there was no difference in percentage of divers with complete relief at three, six, and nine months.

Aeromedical evacuation of a diver is costly, can be logistically difficult, may not result in a clinically relevant reduction in delay to recompression, and is not without risk. These might seem to outweigh any potential benefit in mild DCI. Such conventional cost-benefit analysis is dependent on the integrity of any diagnosis of mild DCI and is clouded due to cultural and social expectation of standard of medical care, and because the cost is usually borne by a third party. Informed risk assessment by the diver in a remote location with mild DCI requires a strong doctor–patient relationship that is unlikely to exist, leaving the doctor to make this decision.

Private ground transportation, usually without supplemental oxygen or intravenous fluids and a typical delay to treatment of 42 hours, is the most common form of retrieval to the recompression facilities in Townsville that service the majority of the Great Barrier Reef. There was no difference in the incidence of residual symptoms at the end of all recompressions between 80 divers with mild symptoms of DCI retrieved by ground transport and 22 divers retrieved by air (typical delay 24 hours).
Where logistics determine the necessity, divers with mild symptoms of DCI can make short-haul flights aboard commercial airliners without any apparent influence on subsequent recompression treatment outcome. DAN data (1998–2002) contained 1,108 divers with pain or mild neurological symptoms of whom 95 flew with symptoms before recompression. There was no significant difference in the incidence of residual symptoms at the end of all recompressions between divers with mild neurological symptoms who did not fly and those who flew more than 24 hours after diving; however, there was a significantly higher incidence of residual symptoms in divers who flew sooner than 24 hours. There were no such differences for divers with pain as their only symptom.

Treatment options in remote locations include non-recompression therapies that should be employed as first aid during any delay to recompression and may be sufficient treatment alone for mild symptoms. Standard non-recompression therapies are based on known pathophysiology and include 100 per cent oxygen breathing (see above), fluid replacement to reduce haemoconcentration, and drugs to reduce platelet activation. Inflammation is probably an important aetiology of mild symptoms, and more trials are needed of non-steroidal anti-inflammatory drugs, antihistamines, and possibly emerging anti-inflammatory therapies. Options for hyperbaric oxygen treatment that may exist in remote locations include recompression chambers not staffed by experienced diving medical officers or in-water recompression. Choice of these options would depend on evaluation of the patient, facilities and staff.

There is a perceived risk of relapse from flying soon after treatment. Current recommendations for delay before flying following treatment are not evidence based and range from three days to six weeks. Amongst 95 divers surveyed by DAN, there was no difference in the rate of relapse (9 per cent) between divers who flew earlier or later than three days following treatment.

As a prelude to producing a consensus statement, two hypothetical cases, one of serious DCI and one of mild DCI, were used to stimulate discussion of workshop issues amongst a panel of experts. These discussions are supplemented by one subjective account of lessons learnt during 25 years of treating DCI in remote locations. The discussions illustrated that no standardised management algorithm could replace clinical judgement. However, there was unanimous support for hypothetical case management that did not require aeromedical evacuation or recompression therapy for a patient with mild symptoms after diving in whom the diagnosis of DCI was equivocal.

The workshop consensus statements generated in regard to these issues are presented at the beginning of the workshop proceedings.

References

1 Levels of evidence in American Family Physician [Internet]. [Leawood(KS)]: American Academy of Family Physicians; c2004 [Cited 2004 Dec 6]. Available at: <http:/ /www.aafp.org/x17444.xml>

Key words
Reprinted from, decompression sickness, treatment, flying (and diving), meetings, DAN – Divers Alert Network, medical society