

Time to fly after hyperbaric chamber treatment for decompression illness: current recommendations

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Key words

Decompression illness, decompression sickness, treatment, flying, altitude, questionnaire

Abstract

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Divers suffering decompression illness (DCI) increasingly undertake high altitude travel after hyperbaric treatment. Anecdotal evidence suggests hyperbaric medical professionals give widely differing advice regarding the safe time to fly after treatment (TFAT), resulting in possible health, socio-economic and insurance implications. Thirty-two chamber facilities were contacted to determine current trends in advice on TFAT and the rationale behind these trends. Twenty-three (72%) facilities responded of which five returned incomplete data, and 18 returned data fulfilling all the criteria. This study collates the current advice given by staff at these 18 chambers, and the basis on which it is given. Only one of the responding chambers had no relevant guidelines. Advised TFAT differed widely, varying from immediately to six weeks. Seven chambers gave advice based on Divers Alert Network (DAN) recommendations, two based on research, and the remaining chambers relied on local staff advice based on their own experience. Only six chambers followed up divers after treatment, leading to a paucity of data regarding complication and recurrence rates following 'return home'. Repeated contact with chambers revealed many units kept inadequate records, or did not have the staffing available to collate information for this study, limiting the success of this type of research. Guidelines on TFAT for DCI vary radically between chambers, and are rarely evidence based.

Introduction

Throughout the world, divers on holiday presenting with decompression illness (DCI) are treated in hyperbaric chambers. Once treatment concludes, part of the medical discharge process includes advice to the diver about when to seek further medical opinion, when it is considered safe to resume diving, and when it is safe to make the return flight to their home country. As there are increasing numbers of tourists who dive whilst on holiday, higher numbers of divers are being treated for DCI and more of these divers are embarking on short- and long-haul flights home after treatment.¹ It is therefore particularly important to know when it is considered 'safe' to fly again, in order to resume work and family life.

Few if any studies have been specifically designed to observe any relationship with recurrences or complications of DCI with altitude provocation after treatment. However, anecdotal evidence does suggest chambers give varying advice regarding TFAT. The aim of this study was to attempt, by means of a questionnaire sent to recompression chambers that treat divers, to collate current advice and the basis on which it is given.

Methods

Hyperbaric chambers routinely treating divers for DCI and located at busy, international, holiday diving destinations served by both short- and long-haul flights were identified.

A questionnaire (Appendix 1) investigating current trends in advice on high altitude travel after treatment was mailed and e-mailed to treatment chambers; data confidentiality was assured. Principal data gathered included chamber guidelines regarding TFAT, the basis of and rationale behind the guidelines (scientific, advice from other authorities, severity of DCI, success of treatment, number of treatments required, 'instinct'), follow-up procedures, and whether records were kept of divers who fly after treatment for DCI.

The initial point of contact at the chambers was the medical director of the unit. Chambers were re-contacted repeatedly by e-mail and/or telephone in order to improve the response rate; continued point of contact was either the medical director or other senior staff.

Statistical analysis was not used in this study. Data are presented as recorded by the chambers from the questionnaire. Data were evaluated from fixed-option responses, and from free-form solicited text that related to defining the origins and development of TFAT recommendations used by the chambers.

Results

Thirty-two chambers were contacted, of which 23 (72%) responded. Of these, five chambers, although expressing willingness to participate, were unable to provide data suitable for inclusion. Therefore, complete data for analysis were available from 18 (56%) of the chambers contacted.

Table 1
Recommendations, source and basis of advice given by 18 responding chamber facilities

Chamber	Recommendations	Basis of recommendations
1	72 hrs	Not given; prudence
2	Different for each case	DAN; "papers"
3	72 hrs to 7 days	DAN; clinical experience; instinct
4	72 hrs	DAN; success of treatment
7	6 weeks	"Science"; success of treatment; experience; instinct
8	2 weeks	Local staff opinion; altitude exposure post diving
9	3 weeks	"Science"
10	4 weeks	Local staff opinion
12	"immediately" to 4 weeks	Local staff opinions differed widely
16	5 days	Review of own data
17	3 days	No guidelines; instinct
26	"immediately" to 72 hrs	DAN; common sense
27	72 hrs	DAN
28	72 hrs; more if severe	Not given
29	72 hrs	Not given
30	72 hrs	DAN and HTNA presentation
31	72 hrs	DAN
32	72 hrs	Clinical experience; instinct; severity of DCI

Relevant guidelines were reported by 17 of these 18 chambers. The advised TFAT in these guidelines differed widely between chambers, varying from immediately to six weeks post cessation of treatment, with the range including: immediately, 24 hours, 72 hours, five to seven days, two, three, four and six weeks (Table 1). In one chamber different personnel quoted immediately, 24 hours and four weeks definitively. Seven chambers definitively quoted 72 hours as TFAT, with 13 chambers stating they generally had a TFAT policy of less than six days. Some chambers additionally have guidelines for high altitude land-travel, with one unit recommending no land-travel over 300 metres for 14 days after treatment. Reduced TFAT times for short-haul (not defined) internal flights as opposed to longer international flights were also intimated. Follow-up phone calls to request return of the questionnaire revealed not all the staff were initially aware of the presence or content of the guidelines within their unit.

Of the 18 chambers that did provide details of the rationale behind their TFAT recommendations, seven quoted Divers Alert Network (DAN) as the reference for their guidelines. Of this group, one also quoted "papers", (which they were unable to reference), and another chamber quoted "science" (a presentation at a Hyperbaric Technicians and Nurses Association meeting in Australia in 1998) as additional support. The remaining chambers based their guidelines variously as follows: the success of previous treatments, experience, instinct, prudence, common sense, review of own unit historical data, and current guidelines for altitude exposure post diving. One chamber stated that advising a delay prior to flying was "useful" as it provided time for a follow-up review of the patient. Six chambers reported following up patients after discharge, with times varying

from one month to three months. Only four chambers regularly kept records of divers flying home after treatment.

Discussion

Concern regarding flying after treatment for DCI stems from both the perceived theoretical risk and anecdotal evidence of relapse during flight. The mechanisms of relapse are postulated to be multi-factorial. Commercial aircraft are normally pressurised to approximately 2,400m, thus according to Boyle's law, any gas bubbles still present will expand in this reduced pressure. It is also postulated that there may be new bubble growth.^{2,3} Relative tissue ischaemia in this hypoxic environment may be more important in relapse of DCI, as bubbles are thought unlikely to remain in a treated case of DCI. This concept, however, remains unsubstantiated.

It can be seen that advice concerning TFAT currently varies widely between hyperbaric chambers. The advice is given with the intention of reducing the risk of complications that may arise due to the atmospheric changes involved in flying. This theory is derived mainly from work conducted on the relative risk of developing DCI during air travel after diving.⁴⁻⁸ The few published papers regarding the time to fly after treatment for DCI, although valuable and interesting, are based on little human research and are open to debate.⁹⁻¹¹

In 1989, the 39th Undersea and Hyperbaric Medical Society Workshop debated guidelines for recreational divers on pre-flight surface time following diving. The same workshop addressed the issue of flying after treatment of decompression sickness.¹² However, no formal definitive guidelines on TFAT resulted.

Butler, in 1992, asked

*“when was it safe for a diver who had sustained an episode of DCI to ascend to altitude?”*¹

He concluded that

“with the increasing popularity of recreational diving and the greater mobility of diving populations, flying after diving will continue to occur with greater frequency. Consequently, detailed follow-up studies of treated divers are now essential.”

Since that time a number of papers have been published theorising and attempting to address the issue of TFAT. These have included case reports, interrogation of retrospective data and, more recently, prospectively attempting to gather data from treating chambers.^{7,9-11} Recently, Acott, having extensively reviewed the current literature and debated the physics and physiology of flight, concluded that four weeks post treatment for DCI was a reasonable time to fly home.³

The wide variation in guidelines for TFAT amongst the chambers returning data for this study is not surprising as there appears to be little or no scientific evidence on which a decision-making process can be based. Some chambers understandably base their advice on theory, their clinical experience and anecdote. It may also be possible that some of the issues relating to TFAT are rooted in recommendations for the time to fly after diving, as cited by one responding chamber.

Staffing levels were often limited, and available resources and the standard of record keeping varied widely between chambers, illustrating that answers to this question from a questionnaire-based study will be limited in value. Five of the chambers contacted stated that their staff were too busy and/or information was not available in an accessible format to answer the questionnaire, but they supported the concept of the study. Thus, these factors were reflected in the response rate to the questionnaire, which was not improved by repeated contact with the chambers or by changing the format of the questionnaire to allow electronic submission.

Telephone contact produced a positive response towards the project, but due to time restraints of staff, full information was not readily available over the telephone. It was during telephone contact that it became evident some chambers did not always record treatments, outcome, and whether or not subsequent high altitude travel was involved. With only some chambers following patients after discharge, there is a paucity of data regarding complications and recurrence rates following return home.

With the advised TFAT guidelines differing so widely between chambers and appearing to be based on scientifically unfounded assumptions, there are significant implications in terms of personal socio-economic issues, together with insurance costs, that are completely unpredictable. All the chambers that responded to the

questionnaire were interested in participating in further research to establish an evidence-based policy for time to fly and high altitude travel after treatment for DCI. The matter of how elements such as short- and long-haul flights are factored into research and TFAT advice would need addressing. It would mean many chambers would have to commit significant amounts of time and energy to work together, implement administrative structures, and follow up treated divers in a disciplined fashion.

Chambers at long-haul holiday destinations are often the busiest with regard to treating divers, and potentially rich in data, but, conversely, the most under-resourced with regard to funding and staff, often relying on local volunteer diving personnel. Thirteen years on from Butler's review, there is clearly still a requirement for further research in this field in order to address these issues, or as one chamber was quoted as saying *“...to bring some order to this madness”*.

Acknowledgement

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Appendix 1

Questionnaire about recommendations for flying after recompression treatment for decompression illness (DCI). All questions pertained to the years 2000, 2001 and 2002.

- 1) Number of divers treated per calendar year:
 - 2) Number of 'holiday' divers requiring to fly or travel to high altitude after treatment:
- In relation to these 'holiday' divers, please answer the following questions:
- 3) Numbers of treated holiday divers with:
 - a) DCI musculoskeletal
 - b) DCI neurological
 - c) Other (please define)
 - 4) Initial tables used for treatment of holiday divers:
 - a) US Navy Table 6
 - b) US Navy Table 5
 - c) Comex 30
 - d) Other (please specify)
 - 5) How many required more than 2 treatments?
 - 6) How many had delayed presentation?
 - 7) How many had a flight to the chamber or long travel issues prior to first treatment?
 - 8) Does your chamber have guidelines on flying after treatment for holiday divers?
Yes / No
 - 9) If Yes to 8), what are your local guidelines?
 - 10) What are these guidelines based on?
 - a) Advice from Divers Alert Network
 - b) Advice from insurance companies
 - c) Advice from local chambers or staff
 - d) Scientific research, if so, please define
 - e) National guidelines
 - f) Other (please specify)
 - 11) If No to 8), what advice do you give holiday divers who need to fly after treatment?
 - 12) Is the advice given based on?
 - a) The severity of the DCI
 - b) The success of the treatment
 - c) The number of treatments required to produce resolution
 - d) The time of onset of DCI to initial treatment
 - e) Instinct; previous good/bad experience
 - f) Other (please specify)
 - 13) Have any holiday diver cases helped to formulate your management and recommendations of time to fly after treatment?
Yes / No
 - 14) If Yes, please define:
 - 15) Do you follow up your holiday divers once home?
Yes / No
 - 16) If Yes to 15), is this done by?
 - a) Letter
 - b) Telephone
 - c) E-mail
 - 17) If Yes to 15), over what time period after discharge?
 - a) 1 month
 - b) 2-3 months
 - c) 4-6 months
 - d) 1 year
 - e) Other (please define)
 - 18) Are records kept of holiday divers who fly after treatment?
Yes / No
 - 19) Are records kept of holiday diver complications and/or deterioration after discharge?
Yes / No
 - 20) Would you be willing to participate in the potential next phase of this project? This will consist of contacting chambers with a questionnaire that would allow us to prospectively follow holiday diver patients treated by that particular unit.
Yes / No