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


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. 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 recombination 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.
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.

### Table 1

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

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

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?"

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
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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References

1 Butler C. Flying after treatment for decompression
2 Vann RD, Denoble P, Emmerman MN, Corson KS.
Flying after diving and decompression sickness. Aviat
Space Environ Med. 1993; 64(9, Pt 1): 801-7.
3 Acott C. Flying after recompression treatment for
decompression illness: why wait four weeks? SPUMS
4 Bassett BE. Diving and altitude: recommendations for
5 Sheffield PJ. Flying after diving guidelines: a review.
6 Millar I. Post diving altitude exposure. SPUMS J. 1996;
26: 135-40.
7 Laursen SB, Gronfeldt W, Jacobsen E. Decompression
sickness after diving and following flying. Ugeskrift
8 Freiberger JJ, Denoble PJ, Vann RD, Pieper CF,
Ugoccioni DM, et al. Estimate of the relative risk of
decompression sickness after air travel following
multiple days of diving. [Abstract] Undersea Hyperb
9 Ugoccioni DM, Dovenbarger JA, Hobgood JA, Moon
RE. Commercial airlift after recompression therapy
for decompression illness. [Abstract] Undersea Hyperb
10 Freiberger JJ, Denoble PJ, Vann RD, Pieper CF,
Ugoccioni DM, et al. The relative risk of decompression
sickness after air travel following diving. Aviat Space
11 Vann RD, Freiberger JJ, Denoble PJ, Dovenbarger J,
Nord D, et al. The risk of relapse from flying after


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 muscoloskeletal
   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

In relation to these ‘holiday’ divers, please answer the following questions:
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