

Monoplace hyperbaric chamber use of U.S. Navy Table 6: A 20-year experience.

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Weaver LK. Monoplace hyperbaric chamber use of U.S. Navy Table 6: A 20-year experience. *Undersea Hyperb Med* 2006; 33(2):85-88. We report a 20-year experience at LDS Hospital, Salt Lake City, UT using the U.S. Navy Treatment Table 6 (TT6) in an oxygen-filled monoplace hyperbaric chamber (1985-2004). Air breathing was provided via a demand regulator fitted with a SCUBA mouthpiece while the patient wore a nose clip. Intubated patients were mechanically ventilated with a Sechrist 500A ventilator, with a modified circuit providing air, when specified. We treated 90 patients: 72 divers (decompression sickness [DCS] = 67, arterial gas embolism [AGE] = 5), 10 hospital-associated AGE, and 8 miscellaneous conditions. They received a total of 118 TT6 (9 TT6 in intubated patients). Ninety-four percent of the TT6 schedules were tolerated and completed. The intolerance rate from two surveyed multiplace chambers was zero and 3% of 100 TT6 schedules each. Failure to complete the TT6 was due to oxygen toxicity (4) and claustrophobia (3). The U.S. Navy TT6 was well tolerated by patients with DCS or AGE treated in monoplace hyperbaric chambers, but tolerance may not be as high as when treated in the multiplace chamber.

INTRODUCTION

Recompression and hyperbaric oxygen therapy are recommended for decompression sickness (DCS) and arterial gas embolism (AGE) (1, 2). Most hyperbaric chambers in the USA are monoplace chambers (3), and patients with DCS or AGE may present to facilities that operate only monoplace chambers. Referral of these patients to multiplace chambers, if more distant than monoplace chambers, could delay optimal therapy and worsen outcome (4). A commonly recommended hyperbaric oxygen protocol for DCS and AGE is the U.S. Navy Treatment Table 6 (TT6) (2). On this table, the patient is compressed to 286 kPa (2.8 atm abs; 60 fsw) initially and the total treatment duration is 4 hours 45 minutes. Based on severity, this treatment table may be extended (4). TT6 requires the patient to breathe air intermittently to reduce oxygen toxicity. Concerns have been expressed about treating DCS or AGE in monoplace chambers due to lack of direct access to the patient (See comments from *The*

Management of Decompression Illness Pre-course, June 27, 2002, La Jolla, CA). Further concerns were expressed that patients might not tolerate TT6 in the monoplace chamber because of the treatment duration, confinement anxiety, and management of side effects, such as a seizure.

As the only hyperbaric oxygen service from 1984 to 2000 in a several hundred-mile radius, we received and treated a number of patients with DCS and AGE. We began to use the U.S. Navy TT6 in 1985. Here we report a 20-year experience treating patients in the monoplace hyperbaric chamber with U.S. Navy TT6.

METHODS

We reviewed all charts of patients with DCS and AGE from 1985 – 2004 at LDS Hospital, Salt Lake City, Utah. We identified all patients treated with the U.S. Navy TT6. For

purposes of this study, intolerance is defined as signs or symptoms that led to stopping the treatment. All patients were treated in 100% oxygen-filled monoplace chambers (2500B or 3200B, Sechrist Industries, Anaheim, CA). Air breathing periods were provided by a demand regulator (Model L451, Life Support Products, Inc., St. Louis, MO) fitted with a SCUBA mouthpiece and supplied with air at 379 to 586 kPa (55 to 85 psig). During these air-breathing periods, patients wore nose clips (#56130, B+F Medical, St. Louis, MO) to minimize oxygen entrainment from the chamber. Intubated patients were ventilated mechanically with a Sechrist 500A ventilator, with a modified circuit designed to provide air, when specified (5). We requested information from the Hyperbaric Medicine Department of Virginia Mason Medical Center, Seattle, Washington and the University of Miami, Miami, Florida regarding patient tolerance of the U.S. Navy TT6, in order to make a comparison. We wondered if the tolerance to TT6 might be influenced by the experience of our department. Therefore, we also compared the tolerance rate in the first 10 years to the latter 10 years.

RESULTS

During this 20-year period we administered the U.S. Navy TT6 to 90 patients: 72 divers, 10 patients with hospital-associated AGE, and 8 with miscellaneous conditions (Table 1).

In the divers' group there were 67 cases of DCS and 5 AGE. Of the total group, seven patients were intubated, and received nine TT6 exposures. Ninety-four percent of the TT6 exposures were tolerated and completed. Nine TT6 exposures had extensions (8 with one extension at 286 kPa (2.8 atm abs, 60 fsw), and 1 with two extensions: one at 2.8 atm abs and one at 1.9 atm abs (193 kPa, 30 fsw). Seven patients did not tolerate the TT6 exposures

(Table 2). Although not counted as having chamber intolerance, two additional patients had amended TT6 because of hypoxemia during required air breathing periods (7).

In the first 10 years, we treated 41 patients (53 treatments) under the TT6 protocol, and 5 patients did not tolerate the TT6 (3 claustrophobia, 2 oxygen toxicity). In the second 10 years of our experience, 2 of 49 patients (65 treatments) did not tolerate the TT6 (oxygen toxicity).

DISCUSSION

The U.S. Navy TT6 was well tolerated by patients with DCS or hospital-associated AGE treated in monoplace hyperbaric chambers. Claustrophobia was unusual. Although the duration of the U.S. Navy TT6 is relatively long, patients treated in monoplace chambers complied reasonably well with this schedule.

Based upon survey information, the intolerance rate of the TT6 was 3/100 treatments from Virginia Mason Medical Center. Eighty-four of these 100 TT6 schedules were extended (except the three in which intolerance developed). The intolerance rate was zero of 100 TT6 from the University of Miami. Eleven of these 100 TT6 schedules had extensions.

Our rate of intolerance appears to be higher than that from two high volume, experienced multiplace chamber departments. However, it is difficult to draw strong inferences from this limited survey. Factors that limit comparing our data to theirs include: patients and their expression of a specific disorder may be dissimilar; use of anxiolytic medications could be different; number of intubated and sedated patients might vary; and an inside attendant may alter the patient's perception or expression of difficulties differently than an attendant located outside the chamber as in the monoplace configuration.

Table 1: Baseline characteristics and treatment extensions of patients receiving US Navy Treatment Table 6 (TT6) in monoplace hyperbaric chambers.

Characteristic	Patients
Patient Characteristic	
Number of patients – no.	90
Female gender – no. (%)	32 (35)
Age of patients – mean $\pm$ 1 standard deviation (years)	34.0 $\pm$ 11.2
Mechanical ventilation – no. of patients	7
Treatment Information	
Treatments using TT6 protocol – no.	118
Extensions	
TT6 treatments receiving 1 extension (60 fsw) – no.	8
TT6 treatments receiving 2 extensions (1-60 fsw, 1-30 fsw) – no.	1
Diagnosis of patients	
Diver decompression sickness	67
Hospital arterial gas embolism	10
Diver arterial gas embolism	5
Aviator decompression sickness	3
Hyperbaric chamber decompression sickness	2
Other arterial gas embolism	1
Cyanide poisoning	1
Diver with factitious DCS	1

Table 2. Summary of reasons for U.S. Navy TT6 intolerance.

TT6 treatments not completed – no. (% of total TT6)	7 (6)
Oxygen toxicity	4
Cough	2
Seizure	1
Nausea	1
Claustrophobia	3

Initially we supplied the demand regulator with air from the hospital air source at 397 kPa (55 psig). However, patients complained of increased effort necessary to breathe. Consequently, we supplied the demand regulators with air delivered at 586 kPa (85 psig) from high-pressure air cylinders, which lessened patient breathing effort during air breathing periods. Centers that provide air breathing periods to compressed patients should appreciate breathing resistance their patients might experience. Delivering air pressure to demand regulators in excess of hospital supply pressures requires an independent air source, which may be necessary to facilitate low breathing resistance. For mechanically

ventilated patients, the ventilator must be able to provide air breathing. Modifications to the Sechrist 500A ventilator circuit permit air delivery (5). The Omni-Vent ventilator (now named the MaxO2-Vent, Oceanic Medical Products, Inc., Atchison, KS) could also deliver air during to intubated patients treated in the monoplace chamber (6).

We appreciate that our department's experience with patients treated with the TT6 may vary from that of other centers. The rate of intolerance to the TT6 in the first 10 years of our experience appears higher than in the most recent 10 years. It is possible that centers that are unfamiliar and lack experience with the TT6 might have a higher intolerance rate. We agree

as noted by Moon (4) that training, experience, and maintaining skills are important for centers that might treat patients with DCI or medically-related AGE.

We did not include two patients who developed hypoxemia during the TT6 as having “intolerance” to the chamber. These two patients were sedated and mechanically ventilated. Arterial blood gas measurements during hyperbaric oxygen therapy documented hypoxemia during air breathing (7). Without blood gas measurements, we would not have discovered the hypoxemia, and these patients appeared to tolerate hyperbaric oxygen satisfactorily.

We did not include outcome data from patients treated with the TT6 in monoplace chambers. The study was retrospective, hence outcome information might be difficult to obtain and might not be accurate. Our purpose was to report experience with the TT6 using monoplace chambers, not to determine whether monoplace chamber care is equivalent to that delivered by multiplace chambers. Thus, in summary, the U.S. Navy TT6 can be used to treat patients in monoplace hyperbaric chambers and appears to be well tolerated, although the intolerance rate was higher compared to two centers operating multiplace hyperbaric chambers.

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