VOLUME 5

Diving Medicine & Recompression Chamber Operations

U.S. NAVY DIVING MANUAL

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CHAPTER 17

Diagnosis and Treatment of Decompression Sickness and Arterial Gas Embolism

17-1 INTRODUCTION

17-1.1 Purpose. This chapter describes the diagnosis and treatment of diving disorders with recompression therapy and/or hyperbaric oxygen therapy. Recompression therapy is indicated for treating DCS, AGE, and several other disorders unless the diver is critically ill or has experienced a drowning episode. In those cases where diagnosis or treatment are not clear, direct the patient to the highest level of medical care available and contact the Diving Medical Officers at NEDU or NDSTC for guidance. The recompression procedures described in this chapter are designed to handle most situations that will be encountered operationally. They are applicable to both surface-supplied and open and closed circuit SCUBA diving as well as recompression chamber operations, whether breathing air, nitrogen-oxygen, helium-oxygen, or 100 percent oxygen. Treatment of decompression sickness during saturation dives is covered separately in Chapter 13 of this manual. Periodic evaluation of U.S. Navy recompression treatment procedures has shown they are effective in relieving symptoms over 90 percent of the time when used as published.

17-1.2 Scope. The procedures outlined in this chapter are to be performed only by trained personnel. Because these procedures are used to treat disorders ranging from mild pain to life-threatening disorders, the degree of medical expertise necessary to carry out proper treatment will vary. Certain procedures, such as starting intravenous (IV) fluid lines and inserting chest tubes, require special training and must not be attempted by untrained individuals. Treatment tables can be initiated without consulting a Dive Medical Officer (DMO), however a DMO should always be contacted at the earliest possible opportunity. A DMO must be contacted prior to releasing the treated individual.

17-2 MANNING REQUIREMENTS

17-2.1 Recompression Chamber Team. A recompression chamber team is assembled in two situations; where a recompression chamber is part of a diving operation, and where a recompression chamber is maintained as an area response requirement. This section applies to both situations. The designation “Chamber Supervisor” may be interchanged with “Diving Supervisor” where a recompression chamber is part of an operation. During a complex recompression treatment, the minimum manning and emergency manning levels specified in Table 17-1 may not be adequate to keep up with the surge of activity required at various points during

the treatment and additional personnel should be obtained as soon as possible. A second team may be required to relieve the initial team during prolonged treatments.

Table 17-1. *Minimum Manning Levels for Recompression Treatments.*

Minimum Manning Levels for Recompression Treatments			
	Minimum	**Ideal**	**Emergency**
Diving Officer		1	
Master Diver		1	
Chamber Supervisor	1(a)	1	1(a)
Diving Medical Officer		1 (b)	
Inside Tender/DMT	1(b,c,d)	1(c,d)	1(b,c,d)
Log Keeper		1	
Outside Tender	1	1	
Total	3	7	2

Notes:

(a) The Chamber Supervisor and outside tender must perform the essential tasks of all other positions while keeping patient care a priority. The Chamber Supervisor must attempt to obtain additional personnel as soon as possible.

(b) If the patient has symptoms of serious DCS or AGE where Basic Life Support (BLS) or advanced medical support may be required (e.g., airway management, or thoracic needle decompression), a Diving Medical Technician (DMT) or DMO should accompany the patient inside the chamber in addition to the inside tender. However, recompression treatment must not be delayed while awaiting the arrival of a DMO or DMT.

(c) The best qualified person available should provide specialized medical care to a patient in the chamber. The best qualified person may be a non-diving surgeon, respiratory therapist, Independent Duty Corpsman (IDC), etc. Since these are emergency exposures, no special medical or physical prerequisites exist. A qualified Inside Tender is required inside the chamber at all times.

(d) Locking in /out personnel. Inside tenders and additional personnel may be locked in and out during the course of a treatment. Chamber periods should be kept within no-decompression limits if possible. However, decompression may be accomplished in the outerlock utilizing the air decompression schedules in Table 9-9. Once an inside tender exceeds exceptional exposure limits of the applicable schedule they are committed to the entire treatment table.

17-2.2 **Diving Officer.** The Diving Officer is responsible to the Commanding Officer for the safe conduct of recompression chamber operations and for presenting

recommended changes to treatment protocols to the Commanding Officer. The Diving Officer is responsible for complying with reporting requirements as listed in Chapter 5 and additional duties as defined in the command dive bill.

17-2.3 **Master Diver.** The Master Diver is the most qualified person to supervise recompression treatments. The Master Diver is trained in diagnosing and treating diving injuries and illnesses and is responsible to the Commanding Officer, via the Diving Officer, for the safe conduct of all phases of chamber operations.

The Master Diver provides direct oversight of the Chamber Supervisor and technical expertise. If circumstances warrant, the Master Diver shall relieve the Chamber Supervisor and assume control of the treatment.

17-2.4 **Chamber Supervisor.** The Chamber Supervisor is responsible for execution of treatment protocols, emergency procedures, and supervision of the chamber team. If the Chamber Supervisor determines the reason for postdive symptoms is firmly established to be due to causes other than decompression sickness or arterial gas embolism (e.g. injury, sprain, poorly fitting equipment), then recompression is not necessary. If the Chamber Supervisor cannot rule out the need for recompression then the Chamber Supervisor must commence treatment. Additionally, the Chamber Supervisor is responsible for:

- Communicating with personnel inside the chamber.
- Adhering to the minimum manning levels for conducting recompression treatment (Table 17-1).
- Ensuring every member of the chamber team is thoroughly familiar with all recompression procedures.
- Ensuring a Diving Medical Officer is contacted at the earliest opportunity during treatment and before release of any patient from the treatment facility.
- Ensuring details related to the assessment and treatment of the patient (e.g. condition prior to treatment, time and depth of complete relief, patient vital signs) are thoroughly documented in the recompression chamber log IAW section 5-5 and the command dive bill.
- Tracking bottom time and the decompression profiles of personnel locking in and out of the chamber.
- Ensuring the decompression profiles of persons locking in and out of the chamber are logged in the chamber log.

17-2.5 **Diving Medical Officer.** The Diving Medical Officer recommends the proper course of treatment, consults with other medical personnel, and prescribes medications and treatment adjuncts. The Diving Medical Officer is the only team member who

can modify recompression treatment tables, with concurrence of the Commanding Officer or Officer-in-Charge.

The DMO typically locks in and out of the chamber as the patient's condition dictates (e.g., to administer advanced procedures, perform differential diagnosis, or to verify complete relief of symptoms), and does not commit to the entire treatment unless absolutely necessary. Once committed to remain in the chamber, the DMO's effectiveness in directing the treatment is greatly diminished and consultation with other medical personnel becomes more difficult.

Recompression treatment for diving related disorders may be initiated without consulting a DMO, however, a DMO shall be consulted as early as possible, and should be consulted before committing a patient to a Treatment Table 4 or 7. The DMO may be on scene or in communication with the Chamber Supervisor.

17-2.5.1 Prescribing and Modifying Treatments. Because all possible outcomes cannot be anticipated, additional medical expertise should be sought immediately in all cases of decompression sickness or arterial gas embolism that do not show substantial improvement on standard treatment tables. Deviation from these protocols shall be made only with the recommendation of a Diving Medical Officer (DMO).

Not all Medical Officers are DMOs. The DMO shall be a graduate of the Diving Medical Officer course taught at the Naval Diving and Salvage Training Center (NDSTC) and have a subspecialty code of 16U0 (Basic Undersea Medical Officer) or 16U1 (Residency in Undersea Medicine trained Undersea Medical Officer). Medical Officers who complete only the nine-week diving medicine course at NDSTC do not receive DMO subspecialty codes, but are considered to have the same privileges as DMOs, with the exception that they are not granted the privilege of modifying treatment protocols. Only DMOs with subspecialty codes 16U0 or 16U1 may modify the treatment protocols as warranted by the patient's condition with the concurrence of the Commanding Officer or Officer in Charge. Other physicians may assist and advise treatment and care of diving casualties but may not modify recompression procedures.

17-2.6 Inside Tender/DMT. When conducting a recompression treatment, at least one qualified tender shall be inside the chamber at all times. The inside tender should be a Diving Medical Technician (DMT) if available, however, any qualified diver or non-diving medical personnel may qualify and perform as an inside tender as stated below.

Diving Medical Technicians receive special training in hyperbaric medicine and medical care and operate under the medical license and supervision of a DMO. DMTs are trained to administer medical treatment adjuncts, handle emergencies that may arise during treatment, and instruct members of the diving team in first aid procedures.

Non-diving medical personnel (e.g., U.S. Naval Reserve Corpsmen, and nursing personnel) may qualify as an Inside Tender via the Military Diver Inside Tender PQS (NAVEDTRA 43910). Non-diving medical personnel must obtain a current

diving physical exam, conform to Navy physical standards, and pass the diver candidate pressure test.

The inside tender shall be familiar with all treatment procedures and the signs, symptoms, and treatment of all diving-related disorders.

During the early phases of treatment, the inside tender must monitor the patient periodically for signs of relief of symptoms. Observation of the patient, to include performance of repeat neurological exams, is the principal method of diagnosing the patient's illness and the depth and time of their relief helps determine which treatment table is used.

The inside tender is also responsible for:

- Releasing the door latches (dogs) after a seal is made.
- Communicating with outside personnel.
- Providing first aid as required by the patient.
- Monitoring the patients vital signs.
- Administering treatment gas to the patient at treatment depth.
- Monitoring the patient for signs of oxygen toxicity. (CNS and Pulmonary)
- Ensuring that sound attenuators for ear protection are worn during compression and ventilation portions of recompression treatments.
- Ensuring that the patient is lying down and positioned to permit free blood circulation to all extremities.

17-2.7 Outside Tender. The outside tender is responsible for preparing the chamber system for use and securing from use IAW the system operating procedures and the chamber pre and post dive checklists. The chamber operator pressurizes and ventilates the chamber at the required rates as specified by the Chamber Supervisor. The outside tender operates the chamber medical lock, maintains the chamber at the required depth, and monitors chamber internal environmental readings, treatment gas bank, and air supply manifold pressures.

17-2.8 Emergency Consultation. Modern communications allow access to medical expertise from even the most remote areas. Emergency consultation is available 24 hours a day with:

Primary:

Navy Experimental Diving Unit (NEDU)

Commercial (850) 230-3100, DSN 436-4351

Secondary:

Navy Diving Salvage and Training Center (NDSTC)

Commercial (850) 234-4651, DSN 436-4651

17-3 ARTERIAL GAS EMBOLISM

Arterial gas embolism is caused by entry of gas bubbles into the arterial circulation as a result of pulmonary over inflation syndrome (POIS). Gas embolism can manifest during any dive where compressed gas is breathed under pressure, even during a brief, shallow dive, or one made in a swimming pool. The onset of symptoms is usually sudden and dramatic, often occurring within minutes after arrival on the surface or even before reaching the surface. For this reason, all persons surfacing from a dive where a compressed gas was breathed, shall remain under the direct observation of the Dive Supervisor for 10 minutes after surfacing. Because the supply of blood to the central nervous system is almost always compromised, arterial gas embolism may result in death or permanent neurological damage unless treated appropriately.

17-3.1 Diagnosis of Arterial Gas Embolism. As a basic rule, any diver who has obtained a breath of compressed gas from any source at any depth, whether from diving apparatus or from a diving bell, and who surfaces unconscious, loses consciousness, or has any obvious neurological symptoms within 10 minutes of reaching the surface, must be assumed to be suffering from arterial gas embolism. Recompression treatment shall be started immediately after airway, breathing, and circulation (ABCs) have been assessed. If the diver is pulseless and not breathing establishment of ABCs is a HIGHER PRIORITY THAN RECOMPRESSION. A diver who surfaces unconscious and recovers when exposed to fresh air shall receive a neurological evaluation to rule out arterial gas embolism. Victims of near-drowning incidents who have no neurological symptoms should ALWAYS be carefully evaluated by a DMO, if available, for pulmonary aspiration, or referred to a higher level of medical care.

The symptoms of AGE may be masked by environmental factors or by other less significant symptoms. A chilled diver may not be concerned with numbness in an arm, which may actually be the sign of CNS involvement. Pain from any source may divert attention from other symptoms. The natural anxiety that accompanies an emergency situation, such as the failure of the diver's air supply, might mask a state of confusion caused by an arterial gas embolism to the brain.

If pain is the only symptom, arterial gas embolism is unlikely and decompression sickness or one of the other pulmonary overinflation syndromes, or trauma, should be considered.

17-3.1.1 **Symptoms of AGE.** The signs and symptoms of AGE may include near immediate onset of altered consciousness, dizziness, paralysis or weakness in the extremities, large areas of abnormal sensation (paresthesias), vision abnormalities, convulsions or personality changes. During ascent, the diver may have noticed a sensation similar to that of a blow to the chest. The victim may become unconscious without warning and may stop breathing. Additional symptoms of AGE include:

- Extreme fatigue
- Difficulty in thinking
- Vertigo
- Nausea and/or vomiting
- Hearing abnormalities
- Bloody sputum
- Loss of control of bodily functions
- Tremors
- Loss of coordination
- Numbness

Symptoms of subcutaneous / mediastinal emphysema, pneumothorax and/or pneumopericardium may also be present (see paragraph 3-8). In all cases of arterial gas embolism, the possible presence of these associated conditions should not be overlooked.

17-3.2 Treating Arterial Gas Embolism. Arterial gas embolism is treated in accordance with Figure 17-1 with initial compression to 60 fsw. If symptoms are improved within the first oxygen breathing period, then treatment is continued using Treatment Table 6. If symptoms are unchanged or worsen, assess the patient upon descent and compress to depth of relief (or significant improvement), not to exceed 165 fsw and follow Figure 17-1.

17-3.3 Resuscitation of a Pulseless Diver. The following are intended as guidelines. On scene personnel must make management decisions considering all known factors. Immediate CPR and application of an Automated External Defibrillator (AED) is indicated for a diver with no pulse or respirations (cardiopulmonary arrest). Access to advanced cardiac life support (ACLS) is a higher priority than recompression. ACLS, which requires special medical training and equipment, is not always available. Although not a substitute for the full range of interventions of ACLS, use of an Automated External Defibrillator (AED) can deliver life-saving shocks when a shockable heart rhythm is detected. CPR, patient monitoring, and drug administration may be performed at depth, but electrical therapy (defibrillation or cardioversion) must be performed on the surface.

CPR must begin immediately and an AED should be placed on the victim as soon as possible. All efforts should be made to immediately transport the patient to the highest level of medical care available while continuing basic life support measures (BLS) measures. If the pulseless diver regains vital signs continue, or begin, transport to the nearest critical care facility prior to recompression.

Effective rescue breathing, excellent chest compressions, and immediate evacuation to a medical facility is the most viable treatment for drowning victims. Delays in access to a critical care facility will most likely will result in an unfavorable outcome for the victim.

A pulseless diver should not be recompressed unless there is no possibility of evacuation. Unless ABCs are restored the diver will likely die, even if adequate CPR is performed, with or without recompression.

CAUTION **Defibrillation is not currently authorized at depth.**

CAUTION **If the tender is outside of no-decompression limits, take appropriate steps to manage the tender's decompression obligation.**

17-3.3.1 **Evacuation not feasible.** If an AED is not available and evacuation is not an option, recompress the patient to 60 feet, continue BLS measures, and contact a UMO. If an AED becomes available, surface the chamber at 30fpm and apply the AED. If the diver regains pulse, continue with recompression and monitor the patient closely.

CAUTION: **If tenders are outside of no-decompression limits, take appropriate steps to manage the tender's decompression obligation. If the pulseless diver does not regain a pulse with application of an AED, continue resuscitation efforts until the diver recovers, the rescuers are unable to continue CPR, or a physician pronounces the patient dead. Avoid recompressing a pulseless diver who has failed to regain vital signs after use of an AED.**

17-4 DECOMPRESSION SICKNESS

While a history of diving (or altitude exposure) is necessary for the diagnosis of decompression sickness to be made, the depth and duration of the dive are useful only in establishing if required decompression was missed. Decompression sickness can occur in divers well within no-decompression limits or in divers who have carefully followed decompression tables. Any decompression sickness that occurs must be treated by recompression.

For purposes of deciding the appropriate treatment, symptoms of decompression sickness are generally divided into two categories, Type I and Type II. Because the treatment of Type I and Type II symptoms may be different, it is important to distinguish between these two types of decompression sickness. The diver may

exhibit certain signs that only trained observers will identify as decompression sickness. Some of the symptoms or signs will be so pronounced that there will be little doubt as to the cause. Others may be subtle and some of the more important signs could be overlooked in a cursory examination. Type I and Type II symptoms may or may not be present at the same time.

17-4.1 **Diagnosis of Decompression Sickness.** Decompression sickness symptoms usually occur shortly following the dive or other pressure exposure. If the controlled decompression during ascent has been shortened or omitted, the diver could be suffering from decompression sickness before reaching the surface. In analyzing several thousand air dives in a database set up by the U.S. Navy for developing decompression models, the time of onset of symptoms after surfacing was as follows:

- 42 percent occurred within 1 hour.
- 60 percent occurred within 3 hours.
- 83 percent occurred within 8 hours.
- 98 percent occurred within 24 hours.

Appendix 5A contains a set of guidelines for performing a neurological examination and an examination checklist to assist trained personnel in evaluating decompression sickness cases.

17-4.2 **Symptoms of Type I Decompression Sickness.** Type I decompression sickness includes joint pain (musculoskeletal or pain-only symptoms) and symptoms involving the skin (cutaneous symptoms), or swelling and pain in lymph nodes.

17-4.2.1 **Musculoskeletal Pain-Only Symptoms.** The most common symptom of decompression sickness is joint pain. Other types of pain may occur which do not involve joints. The pain may be mild or excruciating. The most common sites of joint pain are the shoulder, elbow, wrist, hand, knee, and ankle. The characteristic pain of Type I decompression sickness usually begins gradually, is slight when first noticed and may be difficult to localize. It may be located in a joint or muscle, may increase in intensity, and is usually described as a deep, dull ache. The pain may or may not be increased by movement of the affected joint, and the limb may be held preferentially in certain positions to reduce the intensity (so-called guarding). The hallmark of Type I pain is its dull, aching quality and confinement to particular areas. It is always present at rest and is usually unaffected by movement.

Any pain occurring in the abdominal and thoracic areas, including the hips, should be considered as symptoms arising from spinal cord involvement and treated as Type II decompression sickness. The following symptoms may indicate spinal cord involvement:

- Pain localized to joints between the ribs and spinal column or joints between the ribs and sternum.

Table 17-2. *Rules for Recompression Treatment.*

ALWAYS:

1. Follow the treatment tables accurately, unless modified by a Diving Medical Officer with concurrence of the Commanding Officer or Officer-in-Charge (OIC).
2. Have a qualified tender in the chamber at all times during treatment.
3. Maintain the normal descent and ascent rates as much as possible.
4. Examine the patient thoroughly at depth of relief or treatment depth.
5. Treat an unconscious patient for arterial gas embolism or serious decompression sickness unless the possibility of such a condition can be ruled out without question.
6. Use air treatment tables only if oxygen is unavailable.
7. Be alert for warning signs of oxygen toxicity if oxygen is used.
8. In the event of an oxygen convulsion, remove the oxygen mask and keep the patient from self-harm. Do not force the mouth open during a convulsion.
9. Maintain oxygen usage within the time and depth limitations prescribed by the treatment table.
10. Check the patient's condition and vital signs periodically. Check frequently if the patient's condition is changing rapidly or the vital signs are unstable.
11. Observe patient after treatment for recurrence of symptoms. Observe 2 hours for pain-only symptoms, 6 hours for serious symptoms. Do not release patient without consulting a DMO.
12. Maintain accurate timekeeping and recording.
13. Maintain a well-stocked Primary and Secondary Emergency Kit.

NEVER:

1. Permit any shortening or other alteration of the tables, except under the direction of a Diving Medical Officer.
2. Wait for a bag resuscitator. Use mouth-to-mouth resuscitation with a barrier device immediately if breathing ceases.
3. Interrupt chest compressions for longer than 10 seconds.
4. Permit the use of 100 percent oxygen below 60 feet in cases of DCS or AGE.
5. Fail to treat doubtful cases.
6. Allow personnel in the chamber to assume a cramped position that might interfere with complete blood circulation.

- A shooting-type pain that radiates from the back around the body (radicular or girdle pain).
- A vague, aching pain in the chest or abdomen (visceral pain).

17-4.2.1.1 ***Differentiating Between Type I Pain and Injury.*** The most difficult differentiation is between the pain of Type I decompression sickness and the pain resulting from trauma or other injury such as a muscle strain or bruise. If there is any doubt as to the cause of the pain, assume the diver is suffering from decompression sickness and treat accordingly. Frequently, pain may mask other more significant

symptoms. Pain should not be treated with drugs in an effort to make the patient more comfortable. The pain may be the only way to localize the problem and monitor the progress of treatment.

17-4.2.2 **Cutaneous (Skin) Symptoms.** The most common skin manifestation of decompression sickness is itching. Itching by itself is generally transient and does not require recompression. Faint skin rashes may be present in conjunction with itching. These rashes also are transient and do not require recompression. Mottling or marbling of the skin, known as cutis marmorata (marbling), may precede a symptom of serious decompression sickness and shall be treated by recompression as Type II decompression sickness. This condition starts as intense itching, progresses to redness, and then gives way to a patchy, dark-bluish discoloration of the skin. The skin may feel thickened. In some cases the rash may be raised.

17-4.2.3 **Lymphatic Symptoms.** Lymphatic obstruction may occur, creating localized pain in involved lymph nodes and swelling of the tissues drained by these nodes. Recompression may provide prompt relief from pain. The swelling, however, may take longer to resolve completely and may still be present at the completion of treatment.

17-4.3 Treatment of Type I Decompression Sickness. Type I Decompression Sickness is treated in accordance with Figure 17-2. If a full neurological exam is not completed before initial recompression, treat as Type II DCS.

Symptoms of musculoskeletal pain that have shown absolutely no change after the second oxygen breathing period at 60 feet may be due to orthopedic injury rather than decompression sickness. If, after reviewing the patient's history, the Diving Medical Officer feels that the pain can be related to specific orthopedic trauma or injury, a Treatment Table 5 may be completed. If a Diving Medical Officer is not consulted, Treatment Table 6 shall be used.

17-4.4 Symptoms of Type II Decompression Sickness. In the early stages, symptoms of Type II decompression sickness may not be obvious and the stricken diver may consider them inconsequential. The diver may feel fatigued or weak and attribute the condition to overexertion. Even as weakness becomes more severe the diver may not seek treatment until walking, hearing, or urinating becomes difficult. Initial denial of DCS is common. For this reason, symptoms must be recognized during the post-dive period and treated before they become too severe. Type II, or serious, symptoms are divided into three categories: neurological, inner ear (staggers), and cardiopulmonary (chokes). Type I symptoms may or may not be present at the same time.

17-4.4.1 **Neurological Symptoms.** These symptoms may be the result of involvement of any level of the nervous system. Numbness, paresthesias (a tingling, pricking, creeping, "pins and needles," or "electric" sensation on the skin), decreased sensation to touch, muscle weakness, paralysis, mental status changes, or motor performance alterations are the most common symptoms. Disturbances of higher brain function may result in personality changes, amnesia, bizarre behavior, lightheadedness, lack of coordination, and tremors. Lower spinal cord involvement

can cause disruption of urinary function. Some of these signs may be subtle and can be overlooked or dismissed by the stricken diver as being of no consequence.

The occurrence of any neurological symptom after a dive is abnormal and should be considered a symptom of Type II decompression sickness or arterial gas embolism, unless another specific cause can be found. Normal fatigue is not uncommon after long dives and, by itself, is not usually treated as decompression sickness. If the fatigue is unusually severe, a complete neurological examination is indicated to ensure there is no other neurological involvement.

17-4.4.2 **Inner Ear Symptoms ("Staggers").** The symptoms of inner ear decompression sickness include: tinnitus (ringing in the ears), hearing loss, vertigo, dizziness, nausea, and vomiting. Inner ear decompression sickness has occurred most often in helium-oxygen diving and during decompression when the diver switched from breathing helium-oxygen to air. Inner ear decompression sickness should be differentiated from inner ear barotrauma, since the treatments are different. The "Staggers" has been used as another name for inner ear decompression sickness because of the afflicted diver's difficulty in walking due to vestibular system dysfunction. However, symptoms of imbalance may also be due to neurological decompression sickness involving the cerebellum. Typically, rapid involuntary eye movement (nystagmus) is not present in cerebellar decompression sickness.

17-4.4.3 **Cardiopulmonary Symptoms ("Chokes").** If profuse intravascular bubbling occurs, symptoms of chokes may develop due to congestion of the lung circulation. Chokes may start as chest pain aggravated by inspiration and/or as an irritating cough. Increased breathing rate is usually observed. Symptoms of increasing lung congestion may progress to complete circulatory collapse, loss of consciousness, and death if recompression is not instituted immediately. Careful examination for signs of pneumothorax should be performed on patients presenting with shortness of breath. Recompression is not indicated for pneumothorax if no other signs of DCS or AGE are present.

17-4.4.4 **Differentiating Between Type II DCS and AGE.** Many of the symptoms of Type II decompression sickness are the same as those of arterial gas embolism, although the time course is generally different. (AGE usually occurs within 10 minutes of surfacing.) Since the initial treatment of these two conditions is the same and since subsequent treatment conditions are based on the response of the patient to treatment, treatment should not be delayed unnecessarily in order to make the diagnosis.

17-4.5 Treatment of Type II Decompression Sickness. Type II Decompression Sickness is treated with initial compression to 60 fsw in accordance with Figure 17-1. If symptoms are improved within the first oxygen breathing period, then treatment is continued on a Treatment Table 6. If severe symptoms (e.g. paralysis, major weakness, memory loss, altered consciousness) are unchanged or worsen within the first 20 minutes at 60 fsw, assess the patient during descent and compress to depth of relief (or significant improvement), not to exceed to 165 fsw. Treat on Treatment Table 6A. To limit recurrence, severe Type II symptoms warrant full

extensions at 60 fsw even if symptoms resolve during the first oxygen breathing period.

17-4.6 Decompression Sickness in the Water. In rare instances, decompression sickness may develop in the water while the diver is undergoing decompression. The predominant symptom will usually be joint pain, but more serious manifestations such as numbness, weakness, hearing loss, and vertigo may also occur. Decompression sickness is most likely to appear at the shallow decompression stops just prior to surfacing. Some cases, however, have occurred during ascent to the first stop or shortly thereafter. Treatment of decompression sickness in the water will vary depending on the type of diving equipment in use. Specific guidelines are given in Chapter 9 for air dives, Chapter 12 for surface-supplied helium-oxygen dives, and Chapter 15 for EC-UBA dives.

17-4.7 Symptomatic Omitted Decompression. If a diver has had an uncontrolled ascent and has any symptoms, he should be compressed immediately in a recompression chamber to 60 fsw. Conduct a rapid assessment of the patient and treat accordingly. Treatment Table 5 is not an appropriate treatment for symptomatic omitted decompression. If the diver surfaced from 50 fsw or shallower, compress to 60 fsw and begin Treatment Table 6. If the diver surfaced from a greater depth, compress to 60 fsw or the depth where the symptoms are significantly improved, not to exceed 165 fsw, and begin Treatment Table 6A. Consultation with a Diving Medical Officer should be obtained as soon as possible. For uncontrolled ascent deeper than 165 feet, the diving supervisor may elect to use Treatment Table 8 at the depth of relief, not to exceed 225 fsw.

Treatment of symptomatic divers who have surfaced unexpectedly is difficult when no recompression chamber is on the dive station. Immediate transportation, while receiving 100% surface oxygen, to a recompression facility is indicated; if this is impossible, the guidelines in paragraph 17-5.4 may be useful.

17-4.8 Altitude Decompression Sickness. Decompression sickness may also occur with exposure to subatmospheric pressures (altitude exposure), as in an altitude chamber or sudden loss of cabin pressure in an aircraft. Aviators exposed to altitude may experience symptoms of decompression sickness similar to those experienced by divers. The only major difference is that symptoms of spinal cord involvement are less common and symptoms of brain involvement are more frequent in altitude decompression sickness than hyperbaric decompression sickness. Simple pain, however, still accounts for the majority of symptoms.

17-4.8.1 **Joint Pain Treatment.** If only joint pain was present but resolved before reaching one ata from altitude, then the individual may be treated with two hours of 100 percent oxygen breathing at the surface followed by 24 hours of observation.

17-4.8.2 **Other Symptoms and Persistent Symptoms.** For other symptoms or if joint pain symptoms are present after return to one ata, the stricken individual should be transferred to a recompression facility and treated on the appropriate treatment table, even if the symptoms resolve while in transport. Individuals should be kept on 100 percent oxygen during transfer to the recompression facility.

17-5 RECOMPRESSION TREATMENT FOR DIVING DISORDERS

17-5.1 Primary Objectives. Table 17-1 gives the basic rules that shall be followed for all recompression treatments. The primary objectives of recompression treatment are:

- Compress gas bubbles to a small volume, thus relieving local pressure and restarting blood flow.
- Allow sufficient time for bubble resorption.
- Increase blood oxygen content and thus oxygen delivery to injured tissues.

17-5.2 Guidance on Recompression Treatment. Certain facets of recompression treatment have been mentioned previously, but are so important that they cannot be stressed too strongly:

- Treat promptly and adequately.
- The effectiveness of treatment decreases as the length of time between the onset of symptoms and the treatment increases.
- Do not ignore seemingly minor symptoms. They can quickly become major symptoms.
- Follow the selected treatment table unless changes are recommended by a Diving Medical Officer.
- If multiple symptoms occur, treat for the most serious condition.

17-5.3 Recompression Treatment When Chamber Is Available. Oxygen treatment tables are significantly more effective than air treatment tables. Air treatment tables shall only be used after oxygen system failure or intolerable patient oxygen toxicity problems with DMO recommendation. Treatment Table 4 can be used with or without oxygen but should always be used with oxygen if it is available.

17-5.3.1 **Recompression Treatment With Oxygen.** Use Oxygen Treatment Table 5, 6, 6A, 4, or 7, according to the flowcharts in Figure 17-1, Figure 17-2 and Figure 17-3. The descent rate for all these tables is 20 feet per minute. Upon reaching a treatment depth of 60 fsw or shallower place the patient on oxygen. For treatment depths deeper than 60 fsw, use treatment gas if available.

17-5.3.2 **Recompression Treatments When Oxygen Is Not Available.** Air Treatment Tables 1A, 2A, and 3 (Figures 17-11, 17-12, and 17-13) are provided for use only as a last resort when oxygen is not available. Use Air Treatment Table 1A if pain is relieved at a depth less than 66 feet. If pain is relieved at a depth greater than 66 feet, use Treatment Table 2A. Treatment Table 3 is used for treatment of serious symptoms where oxygen cannot be used. Use Treatment Table 3 if symptoms are relieved

within 30 minutes at 165 feet. If symptoms are not relieved in less than 30 minutes at 165 feet, use Treatment Table 4.

17-5.4 Recompression Treatment When No Recompression Chamber is Available. The Diving Supervisor has two alternatives for recompression treatment when the diving facility is not equipped with a recompression chamber. First and foremost, the patient with suspected DCS or AGE should be administered 100% oxygen during transport, if available. If recompression of the patient is not immediately necessary, the diver may be transported to the nearest appropriate recompression chamber or the Diving Supervisor may elect to complete in-water recompression.

17-5.4.1 **Transporting the Patient.** In certain instances, some delay may be unavoidable while the patient is transported to a recompression chamber. While moving the patient to a recompression chamber, the patient should be kept supine (lying horizontally). Do not put the patient head-down. Additionally, the patient should be kept warm and monitored continuously for signs of obstructed (blocked) airway, cessation of breathing, cardiac arrest, or shock. Always keep in mind that a number of conditions may exist at the same time. For example, the victim may be suffering from both decompression sickness and hypothermia.

17-5.4.1.1 ***Medical Treatment During Transport.*** Always have the patient breathe 100 percent oxygen during transport, if available. If symptoms of decompression sickness or arterial gas embolism are relieved or improve after breathing 100 percent oxygen, the patient should still be recompressed as if the original symptom(s) were still present. Always ensure the patient is adequately hydrated. Give fluids by mouth if the patient is alert and able to tolerate them. Otherwise, an IV should be inserted and intravenous fluids should be started before transport. If the patient must be transported, initial arrangements should have been made well in advance of the actual diving operations. These arrangements, which would include an alert notification to the recompression chamber and determination of the most effective means of transportation, should be posted on the Job Site Emergency Assistant Checklist for instant referral.

17-5.4.1.2 ***Transport by Unpressurized Aircraft.*** If the patient is moved by helicopter or other unpressurized aircraft, the aircraft should be flown as low as safely possible, preferably less than 1,000 feet. Exposure to altitude results in an additional reduction in external pressure and possible additional symptom severity or other complications. If available, always use aircraft that can be pressurized to one atmosphere. If available, transport using the Emergency Evacuation Hyperbaric Stretcher should be considered.

17-5.4.1.3 ***Communications with Chamber.*** Call ahead to ensure that the chamber will be ready and that qualified medical personnel will be standing by. If two-way

communications can be established, consult with the doctor as the patient is being transported.

17-5.4.2 **In-Water Recompression.** Recompression in the water should be considered an option of last resort, to be used only when no recompression facility is on site, symptoms are significant and there is no prospect of reaching a recompression facility within a reasonable timeframe (12–24 hours). In an emergency, an uncertified chamber may be used if, in the opinion of a qualified Chamber Supervisor (DSWS Watchstation 305), it is safe to operate. In divers with severe Type II symptoms, or symptoms of arterial gas embolism (e.g., unconsciousness, paralysis, vertigo, respiratory distress (chokes), shock, etc.), the risk of increased harm to the diver from in-water recompression probably outweighs any anticipated benefit. Generally, these individuals should not be recompressed in the water, but should be kept at the surface on 100 percent oxygen, if available, and evacuated to a recompression facility regardless of the delay. The stricken diver should begin breathing 100 percent oxygen immediately (if it is available). Continue breathing oxygen at the surface for 30 minutes before committing to recompress in the water. If symptoms stabilize, improve, or relief on 100 percent oxygen is noted, do not attempt in-water recompression unless symptoms reappear with their original intensity or worsen when oxygen is discontinued. Continue breathing 100 percent oxygen as long as supplies last, up to a maximum time of 12 hours. The patient may be given air breaks as necessary. If surface oxygen proves ineffective after 30 minutes, begin in-water recompression. To avoid hypothermia, it is important to consider water temperature when performing in-water recompression.

17-5.4.2.1 ***In-Water Recompression Using Air.*** In-water recompression using air is always less preferable than in-water recompression using oxygen.

- Follow Air Treatment Table 1A as closely as possible.
- Use either a full face mask or, preferably, a surface-supplied helmet UBA.
- Never recompress a diver in the water using a SCUBA with a mouth piece unless it is the only breathing source available.
- Maintain constant communication.
- Keep at least one diver with the patient at all times.
- Plan carefully for shifting UBAs or cylinders.
- Have an ample number of tenders topside.
- If the depth is too shallow for full treatment according to Air Treatment Table 1A:
  - Recompress the patient to the maximum available depth.
  - Remain at maximum depth for 30 minutes.
  - Decompress according to Air Treatment Table 1A. Do not use stops shorter than those of Air Treatment Table 1A.

17-5.4.2.2 ***In-Water Recompression Using Oxygen.*** If 100 percent oxygen is available to the diver using an oxygen rebreather, an ORCA, or other device, the following in-water recompression procedure should be used instead of Air Treatment Table 1A:

- Put the stricken diver on the UBA and have the diver purge the apparatus at least three times with oxygen.
- Descend to a depth of 30 feet with a standby diver.
- Remain at 30 feet, at rest, for 60 minutes for Type I symptoms and 90 minutes for Type II symptoms. Ascend to 20 feet even if symptoms are still present.
- Decompress to the surface by taking 60-minute stops at 20 feet and 10 feet.
- After surfacing, continue breathing 100 percent oxygen for an additional 3 hours.
- If symptoms persist or recur on the surface, arrange for transport to a recompression facility regardless of the delay.

17-5.4.2.3 ***Symptoms After In-Water Recompression.*** The occurrence of Type II symptoms after in-water recompression is an ominous sign and could progress to severe, debilitating decompression sickness. It should be considered life-threatening. Operational considerations and remoteness of the dive site will dictate the speed with which the diver can be evacuated to a recompression facility.

17-6 TREATMENT TABLES

17-6.1 Air Treatment Tables. Air Treatment Tables 1A, 2A, and 3 (Figures 17-11, 17-12, and 17-13) are provided for use only as a last resort when oxygen is not available. Oxygen treatment tables are significantly more effective than air treatment tables and shall be used whenever possible.

17-6.2 Treatment Table 5. Treatment Table 5, Figure 17-4, may be used for the following:

- Type I DCS (except for cutis marmorata) symptoms when a complete neurological examination has revealed no other abnormality. After arrival at 60 fsw a neurological exam shall be performed to ensure that no overt neurological symptoms (e.g., weakness, numbness, loss of coordination) are present. If any abnormalities are found, the stricken diver should be treated using Treatment Table 6.
- Asymptomatic omitted decompression
- Treatment of resolved symptoms following in-water recompression
- Follow-up treatments for residual symptoms
- Carbon monoxide poisoning
- Gas gangrene

17-6.3 **Treatment Table 6.** Treatment Table 6, Figure 17-5, is used for the following:

- Arterial gas embolism
- Type II DCS symptoms
- Type I DCS symptoms where relief is not complete within 10 minutes at 60 feet or where pain is severe and immediate recompression must be instituted before a neurological examination can be performed
- Cutis marmorata
- Severe carbon monoxide poisoning, cyanide poisoning, or smoke inhalation
- Asymptomatic omitted decompression
- Symptomatic uncontrolled ascent
- Recurrence of symptoms shallower than 60 fsw

17-6.4 **Treatment Table 6A.** Treatment Table 6A, Figure 17-6, is used to treat arterial gas embolism or decompression symptoms when severe symptoms remain unchanged or worsen within the first 20 minutes at 60 fsw. The patient is compressed to depth of relief (or significant improvement), not to exceed 165 fsw. Once at the depth of relief, begin treatment gas (N_2O_2, HeO_2) if available. Consult with a Diving Medical Officer at the earliest opportunity. If the severity of the patient's condition warrants, the Diving Medical Officer may recommend conversion to a Treatment Table 4.

NOTE **If deterioration or recurrence of symptoms is noted during ascent to 60 feet, treat as a recurrence of symptoms (Figure 17-3).**

17-6.5 **Treatment Table 4.** Treatment Table 4, Figure 17-7, is used when it is determined that the patient would receive additional benefit at depth of significant relief, not to exceed 165 fsw. The time at depth shall be between 30 to 120 minutes, based on the patient's response. If a shift from Treatment Table 6A to Treatment Table 4 is contemplated, a Diving Medical Officer should be consulted before the shift is made.

If oxygen is available, the patient should begin oxygen breathing periods immediately upon arrival at the 60-foot stop. Breathing periods of 25 minutes on oxygen, interrupted by 5 minutes of air, are recommended because each cycle lasts 30 minutes. This simplifies timekeeping. Immediately upon arrival at 60 feet, a minimum of four oxygen breathing periods (for a total time of 2 hours) should be administered. After that, oxygen breathing should be administered to suit the patient's individual needs and operational conditions. Both the patient and tender must breathe oxygen for at least 4 hours (eight 25-minute oxygen, 5-minute air periods), beginning no later than 2 hours before ascent from 30 feet is begun. These oxygen-breathing periods may be divided up as convenient, but at least 2 hours' worth of oxygen breathing periods should be completed at 30 feet.

NOTE **If deterioration or recurrence of symptoms is noted during ascent to 60**

feet, treat as a recurrence of symptoms (Figure 17-3).

17-6.6 **Treatment Table 7.** Treatment Table 7, Figure 17-8, is an extension at 60 feet of Treatment Table 6, 6A, or 4 (or any other nonstandard treatment table). This means that considerable treatment has already been administered. Treatment Table 7 is considered a heroic measure for treating non-responding severe gas embolism or life-threatening decompression sickness and is not designed to treat all residual symptoms that do not improve at 60 feet and should never be used to treat residual pain. Treatment Table 7 should be used only when loss of life may result if the currently prescribed decompression from 60 feet is undertaken. Committing a patient to a Treatment Table 7 involves isolating the patient and having to minister to his medical needs in the recompression chamber for 48 hours or longer. Experienced diving medical personnel shall be on scene.

A Diving Medical Officer should be consulted before shifting to a Treatment Table 7 and careful consideration shall be given to life support capability of the recompression facility. Because it is difficult to judge whether a particular patient's condition warrants Treatment Table 7, additional consultation may be obtained from either NEDU or NDSTC.

When using Treatment Table 7, a minimum of 12 hours should be spent at 60 feet, including time spent at 60 feet from Treatment Table 4, 6, or 6A. Severe Type II decompression sickness and/or arterial gas embolism cases may continue to deteriorate significantly over the first several hours. This should not be cause for premature changes in depth. Do not begin decompression from 60 feet for at least 12 hours. At completion of the 12-hour stay, the decision must be made whether to decompress or spend additional time at 60 feet. If no improvement was noted during the first 12 hours, benefit from additional time at 60 feet is unlikely and decompression should be started. If the patient is improving but significant residual symptoms remain (e.g., limb paralysis, abnormal or absent respiration), additional time at 60 feet may be warranted. While the actual time that can be spent at 60 feet is unlimited, the actual additional amount of time beyond 12 hours that should be spent can only be determined by a Diving Medical Officer (in consultation with on-site supervisory personnel), based on the patient's response to therapy and operational factors. When the patient has progressed to the point of consciousness, can breathe independently, and can move all extremities, decompression can be started and maintained as long as improvement continues. Solid evidence of continued benefit should be established for stays longer than 18 hours at 60 feet. Regardless of the duration at the recompression deeper than 60 feet, at least 12 hours must be spent at 60 feet and then Treatment Table 7 followed to the surface. Additional recompression below 60 feet in these cases should not be undertaken unless adequate life support capability is available.

17-6.6.1 **Decompression.** Decompression on Treatment Table 7 is begun with an upward excursion at time zero from 60 to 58 feet. Subsequent 2-foot upward excursions are made at time intervals listed as appropriate to the rate of decompression:

Table 17-3. *Decompression*

Depth	Ascent Rate	Time Interval
58-40 feet	3 ft/hr	40 min
40-20 feet	2 ft/hr	60 min
20-4 feet	1 ft/hr	120 min

The travel time between stops is considered as part of the time interval for the next shallower stop. The time intervals shown above begin when ascent to the next shallower stop has begun.

17-6.6.2 **Tenders.** When using Treatment Table 7, tenders breathe chamber atmosphere throughout treatment and decompression.

17-6.6.3 **Preventing Inadvertent Early Surfacing.** Upon arrival at 4 feet, decompression should be stopped for 4 hours. At the end of 4 hours, decompress to the surface at 1 foot per minute. This procedure prevents inadvertent early surfacing.

17-6.6.4 **Oxygen Breathing.** On a Treatment Table 7, patients should begin oxygen breathing periods as soon as possible at 60 feet. Oxygen breathing periods of 25 minutes on 100 percent oxygen, followed by 5 minutes breathing chamber atmosphere, should be used. Normally, four oxygen breathing periods are alternated with 2 hours of continuous air breathing. In conscious patients, this cycle should be continued until a minimum of eight oxygen breathing periods have been administered (previous 100 percent oxygen breathing periods may be counted against these eight periods). Beyond that, oxygen breathing periods should be continued as recommended by the Diving Medical Officer, as long as improvement is noted and the oxygen is tolerated by the patient. If oxygen breathing causes significant pain on inspiration, it should be discontinued unless it is felt that significant benefit from oxygen breathing is being obtained. In unconscious patients, oxygen breathing should be stopped after a maximum of 24 oxygen breathing periods have been administered. The actual number and length of oxygen breathing periods should be adjusted by the Diving Medical Officer to suit the individual patient's clinical condition and development of pulmonary oxygen toxicity.

17-6.6.5 **Sleeping, Resting, and Eating.** At least two tenders should be available when using Treatment Table 7, and three may be necessary for severely ill patients. Not all tenders are required to be in the chamber, and they may be locked in and out as required following appropriate decompression tables. The patient may sleep anytime except when breathing oxygen deeper than 30 feet. While asleep, the patient's pulse, respiration, and blood pressure should be monitored and recorded at intervals appropriate to the patient's condition. Food may be taken at any time and fluid intake should be maintained.

17-6.6.6 **Ancillary Care.** Patients on Treatment Table 7 requiring intravenous fluid and/or drug therapy should have these administered in accordance with paragraph 17-12 and associated subparagraphs.

17-6.6.7 **Life Support.** Before committing to a Treatment Table 7, the life-support considerations in paragraph 17-7 must be addressed. Do not commit to a Treatment Table 7 if the internal chamber temperature cannot be maintained at 85°F (29°C) or less.

17-6.7 Treatment Table 8. Treatment Table 8, Figure 17-9, is an adaptation of Royal Navy Treatment Table 65 mainly for treating deep uncontrolled ascents (see Chapter 13) when more than 60 minutes of decompression have been missed. Compress symptomatic patient to depth of relief not to exceed 225 fsw. Initiate Treatment Table 8 from depth of relief. The schedule for Treatment Table 8 from 60 fsw is the same as Treatment Table 7. The guidelines for sleeping and eating are the same as Treatment Table 7.

17-6.8 Treatment Table 9. Treatment Table 9, Figure 17-10, is a hyperbaric oxygen treatment table providing 90 minutes of oxygen breathing at 45 feet. This table is used only on the recommendation of a Diving Medical Officer cognizant of the patient's medical condition. Treatment Table 9 is used for the following:

1. Residual symptoms remaining after initial treatment of AGE/DCS
2. Selected cases of carbon monoxide or cyanide poisoning
3. Smoke inhalation

This table may also be recommended by the cognizant Diving Medical Officer when initially treating a severely injured patient whose medical condition precludes long absences from definitive medical care.

17-7 RECOMPRESSION TREATMENT FOR NON-DIVING DISORDERS

In addition to individuals suffering from diving-related disorders, U.S. Navy recompression chambers are also permitted to conduct emergent hyperbaric oxygen (HBO_2) therapy to treat individuals suffering from cyanide poisoning, carbon monoxide poisoning, gas gangrene, smoke inhalation, necrotizing soft-tissue infections, or arterial gas embolism arising from surgery, diagnostic procedures, or thoracic trauma. If the chamber is to be used for treatment of non-diving related medical conditions other than those listed above, authorization from BUMED Code M95 shall be obtained before treatment begins (BUMEDINST 6320.38 series.) Any treatment of a non-diving related medical condition shall be done under the cognizance of a Diving Medical Officer.

The guidelines given in Table 17-4 for conducting HBO_2 therapy are taken from the Undersea and Hyperbaric Medical Society's Hyperbaric Oxygen (HBO_2) Therapy Committee Report-2014: Approved Indications for Hyperbaric Oxygen Therapy. For each condition, the guidelines prescribe the recommended Treatment Table, the frequency of treatment, and the minimum and maximum number of treatments.

Table 17-4. *Guidelines for Conducting Hyperbaric Oxygen Therapy.*

Indication	Treatment Table	Minimum # Treatments	Maximum # Treatments
Carbon Monoxide Poisoning, acute	Treatment Table 5 or Table 6 as recommended by the DMO	1-3	3
Gas Gangrene (Clostridial Myonecrosis)	Treatment Table 5	3 times in 24 hours 2 times per day for the next 2-5 days	10
Crush Injury, Compartment Syndrome, and other Acute Traumatic Ischemia	Treatment Table 9	2 times per day for 2-7 days	14
Central Retinal Artery Occlusion	Treatment Table 6	2 times daily to clinical plateau (typically < 1 week) plus 3 days	3 days after clinical plateau
Diabetic Foot Ulcer	Treatment Table 9	Daily for 3-4 weeks, based on healing response	30
Healing of Other Problem Wounds	Treatment Table 9	Daily for 3-4 weeks, based on healing response	60
Severe Anemia	Treatment Table 5 or Table 9 as recommended by DMO	3-4 times per day until blood replacement by transfusion or regrowth	variable, guided by clinical response
Intracranial Abscess	Treatment Table 9	1-2 times daily for up to 3 weeks	20
Necrotizing Soft Tissue Infection	Treatment Table 9	2 times daily until stabilization	30
Refractory Osteomyelitis	Treatment Table 5 or Table 9 as recommended by DMO	20-40 treatments	40
Delayed Radiation Injury, Soft Tissue Necrosis, Bony Necrosis	Treatment Table 9	For radiation injury: 30-60 treatments For prophylaxis: 20 treatments before surgery in radiated field; 10 sessions after surgery	60
Compromised Grafts and Flaps	Treatment Table 9	2 times daily up to 30 treatments	20
Acute Thermal Burn Injury	Treatment Table 9	2 times daily up to 30 treatments	30
Idiopathic Sudden Sensori-neural Hearing Loss	Treatment Table 9	10-20 treatments	20

17-8 RECOMPRESSION CHAMBER LIFE-SUPPORT CONSIDERATIONS

The short treatment tables (Oxygen Treatment Tables 5, 6, 6A, 9; Air Treatment Tables 1A and 2A) can be accomplished easily without significant strain on either the recompression chamber facility or support crew. The long treatment tables (Tables 3, 4, 7, and 8) will require long periods of decompression and may tax both personnel and hardware severely.

17-8.1 Oxygen Control. All treatment schedules listed in this chapter are usually performed with a chamber atmosphere of air. To accomplish safe decompression, the oxygen percentage should not be allowed to fall below 19 percent. Oxygen may be added to the chamber by ventilating with air or by bleeding in oxygen from an oxygen breathing system. If a portable oxygen analyzer is available, it can be used to determine the adequacy of ventilation and/or addition of oxygen. If no oxygen analyzer is available, ventilation of the chamber in accordance with paragraph 17-8.4 will ensure adequate oxygenation. Chamber oxygen percentages as high as 25 percent are permitted. If the chamber is equipped with a life-support system so that ventilation is not required and an oxygen analyzer is available, the oxygen level should be maintained between 19 percent and 25 percent. If chamber oxygen goes above 25 percent, ventilation with air should be used to bring the oxygen percentage down.

17-8.2 Carbon Dioxide Control. Ventilation of the chamber in accordance with paragraph 17-8.4 will ensure that carbon dioxide produced metabolically does not cause the chamber carbon dioxide level to exceed 1.5 percent SEV (11.4 mmHg).

17-8.2.1 **Carbon Dioxide Monitoring.** Chamber carbon dioxide should be monitored with electronic carbon dioxide monitors. Monitors generally read CO_2 percentage once chamber air has been exhausted to the surface. The CO_2 percent reading at the surface 1 ata must be corrected for depth. To keep chamber CO_2 below 1.5 percent SEV (11.4 mmHg), the surface CO_2 monitor values should remain below 0.78 percent with chamber depth at 30 feet, 0.53 percent with chamber depth at 60 feet, and 0.25 percent with the chamber at 165 feet. If the CO_2 analyzer is within the chamber, no correction to the CO_2 readings is necessary.

17-8.2.2 **Carbon Dioxide Scrubbing.** If the chamber is equipped with a carbon dioxide scrubber, the absorbent should be changed when the partial pressure of carbon dioxide in the chamber reaches 1.5 percent SEV (11.4 mmHg). If absorbent cannot be changed, supplemental chamber ventilation will be required to maintain chamber CO_2 at acceptable levels. With multiple or working chamber occupants, supplemental ventilation may be necessary to maintain chamber CO_2 at acceptable levels.

17-8.2.3 **Carbon Dioxide Absorbent.** CO_2 absorbent in an opened but resealed bucket may be used until the expiration date on the bucket is reached. Pre-packed, double-bagged canisters shall be labeled with the expiration date from the absorbent bucket. Expired CO_2 absorbent shall not be used in any recompression chamber.

17-8.3 Temperature Control. Internal chamber temperature should be maintained at a level comfortable to the occupants whenever possible. Cooling can usually be accomplished by chamber ventilation. If the chamber is equipped with a heater/chiller unit, temperature control can usually be maintained for chamber occupant comfort under any external environmental conditions. Usually, recompression chambers will become hot and must be cooled continuously. Chambers should always be shaded from direct sunlight. The maximum durations for chamber occupants will depend on the internal chamber temperature as listed in Table 17-5. Never commit to a treatment table that will expose the chamber occupants to

greater temperature/time combinations than listed in Table 17-5 unless qualified medical personnel who can evaluate the trade-off between the projected heat stress and the anticipated treatment benefit are consulted. A chamber temperature below 85°F (29°C) is always desirable, no matter which treatment table is used.

For patients with brain or spinal cord damage, the current evidence recommends aggressive treatment of elevated body temperature. When treating victims of AGE or severe neurological DCS, hot environments that elevate body temperature above normal should be avoided, whenever possible. Patient temperature should be a routinely monitored vital sign.

Table 17-5. *Maximum Permissible Recompression Chamber Exposure Times at Various Internal Chamber Temperatures.*

Internal Temperature	Maximum Tolerance Time	Permissible Treatment Tables
Over 104°F (40°C)	Intolerable	No treatments
95–104°F (34.4–40°C)	2 hours	Table 5, 9
85–94°F (29–34.4°C)	6 hours	Tables 5, 6, 6A, 1A, 9
Under 85°F (29°C)	Unlimited	All treatments

NOTE:
Internal chamber temperature can be kept considerably below ambient by venting or by using an installed chiller unit. Internal chamber temperature can be measured using electronic, bimetallic, alcohol, or liquid crystal thermometers. Never use a mercury thermometer in or around hyperbaric chambers. Since chamber ventilation will produce temperature swings during ventilation, the above limits should be used as averages when controlling temperature by ventilation. Always shade chamber from direct sunlight.

17-8.3.1 **Patient Hydration.** Always ensure patients are adequately hydrated. Fully conscious patients may be given fluid by mouth to maintain adequate hydration. One to two liters of water, juice, or non-carbonated drink, over the course of a Treatment Table 5 or 6, is usually sufficient. Patients with Type II symptoms, or symptoms of arterial gas embolism, should be considered for IV fluids. Stuporous or unconscious patients should always be given IV fluids, using large-gauge plastic catheters. If trained personnel are present, an IV should be started as soon as possible and kept dripping at a rate of 75 to 100 cc/hour, using isotonic fluids (Lactated Ringer's Solution, Normal Saline) until specific instructions regarding the rate and type of fluid administration are given by qualified medical personnel. Avoid solutions containing glucose (Dextrose) if brain or spinal cord injury is present. Intravenously administered glucose may worsen the outcome. In some cases, the bladder may be paralyzed. The victim's ability to void shall be assessed as soon as possible. If the patient cannot empty a full bladder, a urinary catheter shall be inserted as soon as possible by trained personnel. Always inflate catheter balloons with liquid, not air. Adequate fluid is being given when urine output is at least 0.5cc/kg/hr. Thirst is an unreliable indicator of the water intake to compensate

for heavy sweating. A useful indicator of proper hydration is a clear colorless urine.

17-8.4 **Chamber Ventilation.** Ventilation is the usual means of controlling oxygen level, carbon dioxide level, and temperature. Ventilation using air is required for chambers without carbon dioxide scrubbers and atmospheric analysis. A ventilation rate of two acfm for each resting occupant, and four acfm for each active occupant, should be used. These procedures are designed to assure that the effective concentration of carbon dioxide will not exceed 1.5 percent sev (11.4 mmHg) and that, when oxygen is being used, the percentage of oxygen in the chamber will not exceed 25 percent.

17-8.5 **Access to Chamber Occupants.** Recompression treatments usually require access to occupants for passing in items such as food, water, and drugs and passing out such items as urine, excrement, and trash. Never attempt a treatment longer than a Treatment Table 6 unless there is access to inside occupants. When doing a Treatment Table 4, 7, or 8, a double-lock chamber is mandatory because additional personnel may have to be locked in and out during treatment.

17-8.6 **Inside Tender Oxygen Breathing.** During treatments, all chamber occupants may breathe 100 percent oxygen at depths of 45 feet or shallower without locking in additional personnel. Tenders should not fasten the oxygen masks to their heads, but should hold them on their faces. When deeper than 45 feet, at least one chamber occupant must breathe air. Tender oxygen breathing requirements are specified in the figure for each Treatment Table.

17-8.7 **Tending Frequency.** Normally, tenders should allow a surface interval of at least 18 hours between consecutive treatments on Treatment Tables 1A, 2A, 3, 5, 6, and 6A, and at least 48 hours between consecutive treatments on Tables 4, 7, and 8. If necessary, however, tenders may repeat Treatment Tables 5, 6, or 6A within this 18-hour surface interval if oxygen is breathed at 30 feet and shallower as outlined in Table 17-7. Minimum surface intervals for Treatment Tables 1A, 2A, 3, 4, 7, and 8 shall be strictly observed.

17-8.8 **Equalizing During Descent.** Descent rates may have to be decreased as necessary to allow the patient to equalize; however, it is vital to attain treatment depth in a timely manner for a suspected arterial gas embolism patient.

17-8.9 **Use of High Oxygen Mixes.** High oxygen N_2O_2/HeO_2 mixtures may be used to treat patients when recompression deeper than 60 fsw is required. These mixtures offer significant therapeutic advantages over air. Select a treatment gas that will produce a ppO_2 between 1.5 and 3.0 ata at the treatment depth. The standardized gas mixtures shown in Table 17-6 are suitable over the depth range of 61-225 fsw.

Decompression sickness following helium dives can be treated with either nitrogen or helium mixtures. For recompression deeper than 165 fsw, helium mixtures are preferred to avoid narcosis. The situation is less clear for treatment of decompression sickness following air or nitrogen-oxygen dives. Experimental studies have shown both benefit and harm with helium treatment. Until more experience is obtained,

high oxygen mixtures with nitrogen as the diluent gas are preferred if available. High oxygen mixtures may also be substituted for 100% oxygen at 60 fsw and shallower on Treatment Tables 4, 7, and 8 if the patient is unable to tolerate 100% oxygen.

Table 17-6. *High Oxygen Treatment Gas Mixtures.*

Depth (fsw)	Mix (HeO_2 or N_2O_2)	ppO_2
0-60	100%	1.00-2.82
61-165	50/50	1.42-3.00
166-225	64/36 (HeO_2 only)	2.17-2.81

17-8.10 **Oxygen Toxicity During Treatment.** Acute CNS oxygen toxicity may develop on any oxygen treatment table.

During prolonged treatments on Treatment Tables 4, 7, or 8, and with repeated Treatment Table 6, pulmonary oxygen toxicity may also develop.

17-8.10.1 **Central Nervous System Oxygen Toxicity.** When employing the oxygen treatment tables, tenders must be particularly alert for the early symptoms of CNS oxygen toxicity. The symptoms can be remembered readily by using the mnemonic VENTID-C (Vision, Ears, Nausea, Twitching\Tingling, Irritability, Dizziness, Convulsions). Unfortunately, a convulsion may occur without early warning signs or before the patient can be taken off oxygen in response to the first sign of CNS oxygen toxicity. CNS oxygen toxicity is unlikely in resting individuals at chamber depths of 50 feet or shallower and very unlikely at 30 feet or shallower, regardless of the level of activity. However, patients with severe Type II decompression sickness or arterial gas embolism symptoms may be abnormally sensitive to CNS oxygen toxicity. Convulsions unrelated to oxygen toxicity may also occur and may be impossible to distinguish from oxygen seizures.

17-8.10.1.1 ***Procedures in the Event of CNS Oxygen Toxicity.*** At the first sign of CNS oxygen toxicity, the patient should be removed from oxygen and allowed to breathe chamber air. Fifteen minutes after all symptoms have subsided, resume oxygen breathing. For Treatment Tables 5, 6, 6A resume treatment at the point of interruption. For Treatment Tables 4, 7 and 8 no compensatory lengthening of the table is required. If symptoms of CNS oxygen toxicity develop again or if the first symptom is a convulsion, take the follow action:

CAUTION **Inserting an airway device or bite block is not recommended while the patient is convulsing; it is not only difficult, but may cause harm if attempted.**

For Treatment Tables 5, 6, and 6A:

- Remove the mask.

- After all symptoms have completely subsided, decompress 10 feet at a rate of 1 fsw/min. For a convulsion, begin travel when the patient is fully relaxed and breathing normally.
- Resume oxygen breathing at the shallower depth at the point of interruption.
- If another oxygen symptom occurs after ascending 10 fsw, contact a Diving Medical Officer to recommend appropriate modifications to the treatment schedule.

For Treatment Tables 4, 7, and 8:

- Remove the mask.
- Consult with a Diving Medical Officer before administering further oxygen breathing. No compensatory lengthening of the table is required for interruption in oxygen breathing.

17-8.10.2 **Pulmonary Oxygen Toxicity.** Pulmonary oxygen toxicity is unlikely to develop on single Treatment Tables 5, 6, or 6A. On Treatment Tables 4, 7, or 8 or with repeated Treatment Tables 5, 6, or 6A (especially with extensions) prolonged exposure to oxygen may result in end-inspiratory discomfort, progressing to substernal burning and severe pain on inspiration. If a patient who is responding well to treatment complains of substernal burning, discontinue use of oxygen and consult with a DMO. However, if a significant neurological deficit remains and improvement is continuing (or if deterioration occurs when oxygen breathing is interrupted), oxygen breathing should be continued as long as considered beneficial or until pain limits inspiration. If oxygen breathing must be continued beyond the period of substernal burning, or if the 2-hour air breaks on Treatment Tables 4, 7, or 8 cannot be used because of deterioration upon the discontinuance of oxygen, the oxygen breathing periods should be changed to 20 minutes on oxygen, followed by 10 minutes breathing chamber air or alternative treatment gas mixtures with a lower percentage of oxygen should be considered. The Diving Medical Officer may tailor the above guidelines to suit individual patient response to treatment.

17-8.11 Loss of Oxygen During Treatment. Loss of oxygen breathing capability during oxygen treatments is a rare occurrence. However, should it occur, the following actions should be taken:

If repair can be completed within 15 minutes:

- Maintain depth until repair is completed.
- After O_2 is restored, resume treatment at point of interruption.

If repair can be completed after 15 minutes but before 2 hours:

- Maintain depth until repair is completed.
- After O_2 is restored: If original table was Table 5, 6, or 6A, complete treatment with maximum number of O_2 extensions.

17-8.11.1 **Compensation.** If Table 4, 7, or 8 is being used, no compensation in decompression is needed if oxygen is lost. If decompression must be stopped because of worsening symptoms in the affected diver, then stop decompression. When oxygen is restored, continue treatment from where it was stopped.

17-8.11.2 **Switching to Air Treatment Table.** If O_2 breathing cannot be restored in 2 hours switch to the comparable air treatment table at current depth for decompression if 60 fsw or shallower. Rate of ascent must not exceed 1 fpm between stops. If symptoms worsen and an increase in treatment depth deeper than 60 feet is needed, use Treatment Table 4.

17-8.12 Treatment at Altitude. Before starting recompression therapy, zero the chamber depth gauges to adjust for altitude. Then use the depths as specified in the treatment table. There is no need to "Cross Correct" the treatment table depths. Divers serving as inside tenders during hyperbaric treatments at altitude are performing a dive at altitude and therefore require more decompression than at sea level. Tenders locking into the chamber for brief periods should be managed according to the Diving At Altitude procedures (paragraph 9-13). Tenders remaining in the chamber for the full treatment table must breathe oxygen during the terminal portion of the treatment to satisfy their decompression requirement.

The additional oxygen breathing required at altitude on Treatment Table 5, Treatment Table 6, and Treatment Table 6A is given in Table 17-6. The requirement pertains both to tenders equilibrated at altitude and to tenders flown directly from sea level to the chamber location. Contact NEDU for guidance on tender oxygen requirements for other treatment tables.

17-9 POST-TREATMENT CONSIDERATIONS

Tenders on Treatment Tables 5, 6, 6A, 1A, 2A, or 3 should have a minimum of a 18-hour surface interval before no-decompression diving and a minimum of a 24-hour surface interval before dives requiring decompression stops. Tenders on Treatment Tables 4, 7, and 8 should have a minimum of a 48-hour surface interval prior to diving.

17-9.1 Post-Treatment Observation Period. After a treatment, patients treated on a Treatment Table 5 should remain at the recompression chamber facility for 2 hours. Patients who have been treated for Type II decompression sickness or who required a Treatment Table 6 for Type I symptoms and have had complete relief should remain at the recompression chamber facility for 6 hours. Patients treated on Treatment Tables 6, 6A, 4, 7, 8 or 9 are likely to require a period of hospitalization, and the Diving Medical Officer will need to determine a post-treatment observation period and location appropriate to their response to recompression treatment. These times may be shortened upon the recommendation of a Diving Medical Officer, provided the patient will be with personnel who are experienced at recognizing recurrence of symptoms and can return to the recompression facility within 30 minutes. All patients should remain within 60 minutes travel time of a recompression facility for 24 hours and should be accompanied throughout that period. No patient shall be released until authorized by a DMO.

Treatment table profiles place the inside tender(s) at risk for decompression sickness. After completing treatments, inside tenders should remain in the vicinity of the recompression chamber for 1 hour. If they were tending for Treatment Table 4, 7, or 8, inside tenders should also remain within 60 minutes travel time of a recompression facility for 24 hours.

Table 17-7. *Tender Oxygen Breathing Requirements. (Note 1)*

		Altitude		
Treatment Table (TT)		Surface to 2499 ft	2500 ft. - 7499 ft.	7500 ft. - 10,000 ft.
TT5 Note (2)	without extension	:00	:00	:00
	with extension @ 30 fsw	:00	:00	:20
TT6 Note (2)	up to one extension @ 60 fsw or 30 fsw	:30	:60	:90
	more than one extension	:60	:90	:120
TT6A Note (2)	up to one extension @ 60 fsw or 30 fsw	:60	:120	:150 Note (3)
	more than one extension	:90	:150 Note (3)	:180 Note (3)

Note 1: All tender O_2 breathing times in table are conducted at 30 fsw. In addition, tenders will breathe O_2 on ascent from 30 fsw to the surface.

Note 2: If the tender had a previous hyperbaric exposure within 18 hours, use the following guidance for administering O_2:
For TT5, add an additional 20 minute O_2 breathing period to the times in the table.
For TT6 or TT6A, add an additional 60 minute O_2 breathing period to the times in the table.
For other Treatment tables contact NEDU for guidance.

Note 3: In some instances, tender's oxygen breathing obligation exceeds the table stay time at 30 fsw. Extend the time at 30 fsw to meet these obligations if patient's condition permits. Otherwise, administer O_2 to the tender to the limit allowed by the treatment table and observe the tender on the surface for 1 hour for symptoms of DCS.

17-9.2 **Post-Treatment Transfer.** Patients with residual symptoms should be transferred to appropriate medical facilities as directed by qualified medical personnel. If ambulatory patients are sent home, they should always be accompanied by someone familiar with their condition who can return them to the recompression facility should the need arise. Patients completing treatment do not have to remain in the vicinity of the chamber if the Diving Medical Officer feels that transferring them to a medical facility immediately is in their best interest.

17-9.3 **Flying After Treatments.** Patients with residual symptoms should fly only with the concurrence of a Diving Medical Officer. Patients who have been treated for decompression sickness or arterial gas embolism and have complete relief should not fly for 72 hours after treatment, at a minimum.

Tenders on Treatment Tables 5, 6, 6A, 1A, 2A, or 3 should have a 24-hour surface interval before flying. Tenders on Treatment Tables 4, 7, and 8 should not fly for 72 hours.

17-9.3.1 **Emergency Air Evacuation.** Some patients will require air evacuation to another treatment or medical facility immediately after surfacing from a treatment. They will not meet surface interval requirements as described above. Such evacuation is done only on the recommendation of a Diving Medical Officer. Aircraft pressurized to one ata should be used if possible, or unpressurized aircraft flown as low as safely possible (no more than 1,000 feet is preferable). Have the patient breathe 100 percent oxygen during transport, if available. If available, an Emergency Evacuation Hyperbaric Stretcher to maintain the patient at 1ata may be used.

17-9.4 Treatment of Residual Symptoms. After completion of the initial recompression treatment and after a surface interval sufficient to allow complete medical evaluation, additional recompression treatments may be instituted. If additional recompression treatments are indicated a Diving Medical Officer must be consulted. Residual symptoms may remain unchanged during the first one or two treatments. In these cases, the Diving Medical Officer is the best judge as to the number of recompression treatments. Consultation with NEDU or NDSTC may be appropriate. As the delay time between completion of initial treatment and the beginning of follow-up hyperbaric treatments increases, the probability of benefit from additional treatments decreases. However, improvement has been noted in patients who have had delay times of up to 1 week. Therefore, a long delay is not necessarily a reason to preclude follow-up treatments. Once residual symptoms respond to additional recompression treatments, such treatments should be continued until no further benefit is noted. In general, treatment may be discontinued if there is no further sustained improvement after two consecutive treatments.

For persistent Type II symptoms, daily treatment on Table 6 may be used, but twice-daily treatments on Treatment Tables 5 or 9 may also be used. The treatment table chosen for re-treatments must be based upon the patient's medical condition and the potential for pulmonary oxygen toxicity. Patients surfacing from Treatment Table 6A with extensions, 4, 7, or 8 may have severe pulmonary oxygen toxicity and may find breathing 100 percent oxygen at 45 or 60 feet to be uncomfortable or even intolerable. In these cases, daily treatments at 30 feet may also be used. As many oxygen breathing periods (25 minutes on oxygen followed by 5 minutes on air) should be administered as can be tolerated by the patient. Ascent to the surface is at 20 feet per minute. A minimum oxygen breathing time is 90 minutes. A practical maximum bottom time is 3 to 4 hours at 30 feet. Treatments should not be administered on a daily basis for more than 5 days without a break of at least 1 day. These guidelines may have to be modified by the Diving Medical Officer to suit individual patient circumstances and tolerance to oxygen as measured by decrements in the patient's vital capacity.

17-9.5 Returning to Diving after Recompression Treatment. Divers diagnosed with any POIS or DCS shall be referred to a DMO for clearance prior to returning to diving. In most cases, a waiver of the physical standards will be required from BUPERS via BUMED. Refer to Bureau of Medicine and Surgery Manual (MANMED) P117 Article 15-102 for guidance.

17-10 NON-STANDARD TREATMENTS

The treatment recommendations presented in this chapter should be followed as closely as possible unless it becomes evident that they are not working. Only a Diving Medical Officer may then recommend changes to treatment protocols or use treatment techniques other than those described in this chapter. Any modifications to treatment tables shall be approved by the Commanding Officer. The standard treatment procedures in this chapter should be considered minimum treatments. Treatment procedures should never be shortened unless emergency situations arise that require chamber occupants to leave the chamber early, or the patient's medical condition precludes the use of standard U.S. Navy treatment tables.

17-11 RECOMPRESSION TREATMENT ABORT PROCEDURES

Once recompression therapy is started, it should be completed according to the procedures in this chapter unless the diver being treated dies or unless continuing the treatment would place the chamber occupants in mortal danger or in order to treat another more serious medical condition.

17-11.1 Death During Treatment. If it appears that the diver being treated has died, a Diving Medical Officer shall be consulted before the treatment is aborted. Once the decision to abort is made, there are a number of options for decompressing the tenders depending on the depth at which the death occurred and the preceding treatment profile.

- If death occurs following initial recompression to 60, 165, or 225 on Treatment Tables 6, 6A, 4 or 8, decompress the tenders on the Air/Oxygen schedule in the Air Decompression Table having a depth exactly equal to or deeper than the maximum depth attained during the treatment and a bottom time equal to or longer than the total elapsed time since treatment began. The Air/Oxygen schedule can be used even if gases other than air (i.e., nitrogen-oxygen or helium-oxygen mixtures) were breathed at depth.

- If death occurs after leaving the initial treatment depth on Treatment Tables 6 or 6A, decompress the tenders at 30 fsw/min to 30 fsw and have them breathe oxygen at 30 fsw for the times indicated in Table 17-6. Following completion of the oxygen breathing time at 30 fsw, decompress the tenders on oxygen from 30 fsw to the surface at 1 fsw/min.

- If death occurs after leaving the initial treatment depth on Treatment Tables 4 or 8, or after beginning treatment on Treatment Table 7 at 60 fsw, have the tenders decompress by continuing on the treatment table as written, or consult NEDU for a decompression schedule customized for the situation at hand. If neither option is possible, follow the original treatment table to 60 fsw. At 60 fsw, have the tenders breathe oxygen for 90 min in three 30-min periods separated by a 5-min air break. Continue decompression at 50, 40 and 30 fsw by breathing oxygen for 60 min at each depth. Ascend between stops at 30 fsw/min. At 50 fsw, breathe oxygen in two 30-min periods separated by a 5-min air

break. At 40 and 30 fsw, breathe oxygen for the full 60-min period followed by a 15-min air break. Ascend to 20 fsw at 30 fsw/min and breathe oxygen for 120 min. Divide the oxygen time at 20 fsw into two 60-min periods separated by a 15 min air break. When oxygen breathing time is complete at 20 fsw, ascend to the surface at 30 fsw/min. Upon surfacing, observe the tenders carefully for the occurrence of decompression sickness.

17-11.2 Impending Natural Disasters or Mechanical Failures. Impending natural disasters or mechanical failures may force the treatment to be aborted. For instance, the ship where the chamber is located may be in imminent danger of sinking or a fire or explosion may have severely damaged the chamber system to such an extent that completing the treatment is impossible. In these cases, the abort procedure described in paragraph 17-11.1 could be used for all chamber occupants (including the stricken diver) if time is available. If time is not available, the following may be done:

1. If deeper than 60 feet, go immediately to 60 feet.

2. Once the chamber is 60 feet or shallower, put all chamber occupants on continuous 100 percent oxygen. Select the Air/Oxygen schedule in the Air Decompression Table corresponding to the maximum depth attained during treatment and the total elapsed time since treatment began.

3. If at 60 fsw, breathe oxygen for period of time equal to the sum of all the decompression stops 60 fsw and deeper in the Air/Oxygen schedule, then continue decompression on the Air/Oxygen schedule, breathing oxygen continuously. If shallower than 60 fsw, breathe oxygen for a period of time equal to the sum of all the decompression stops deeper than the divers current depth, then continue decompression on the Air/Oxygen schedule, breathing oxygen continuously. Complete as much of the Air/Oxygen schedule as possible.

4. When no more time is available, bring all chamber occupants to the surface (try not to exceed 10 feet per minute) and keep them on 100 percent oxygen during evacuation, if possible.

5. Immediately evacuate all chamber occupants to the nearest recompression facility and treat according to Figure 17-1. If no symptoms occurred after the treatment was aborted, follow Treatment Table 6.

17-12 ANCILLARY CARE AND ADJUNCTIVE TREATMENTS

WARNING Drug therapy shall be administered only after consultation with a Diving Medical Officer and only by qualified inside tenders adequately trained and capable of administering prescribed medications.

Most U.S. military diving operations have the unique advantage over most other diving operations with the ability to provide rapid recompression for the victims of decompression sickness (DCS) and arterial gas embolism (AGE). When stricken

divers are treated without delay, the success rate of standard recompression therapy is extremely good.

Some U.S. military divers, such as Special Operations Forces, however, may not have the benefit of a chamber nearby. Diving missions in Special Operations are often conducted in remote areas and may entail a lengthy delay to recompression therapy in the event of a diving accident. Delays to treatment for DCS and AGE significantly increase the probability of severe or refractory disease. In these divers, the use of adjunctive therapy (treatments other than recompression on a treatment table) can be provided while the diver is being transported to a chamber. Adjunctive therapies may also be useful for divers with severe symptoms or who have an incomplete response to recompression and hyperbaric oxygen.

Note that the adjunctive therapy guidelines are separated by accident type, with DCS and AGE covered separately. Although there is some overlap between the guidelines for these two disorders (as with the recompression phase of therapy), the best adjunctive therapy for one disorder is not necessarily the best therapy for the other. Although both DCS and AGE have in common the presence of gas bubbles in the body and a generally good response to recompression and hyperbaric oxygen, the underlying pathophysiology is somewhat different.

17-12.1 Decompression Sickness.

17-12.1.1 **Surface Oxygen.** Surface oxygen should be used for all cases of DCS until the diver can be recompressed. Use of either a high-flow (15 liters/minute) oxygen source with a reservoir mask or a demand valve can achieve high inspired fractions of oxygen. One consideration in administering surface oxygen is pulmonary oxygen toxicity. 100% oxygen can generally be tolerated for up to 12 hours. The patient may be given air breaks as necessary. If oxygen is being administered beyond this time, the decision to continue must weigh the perceived benefits against the risk of pulmonary oxygen toxicity. This risk evaluation must consider the dose of oxygen anticipated with subsequent recompression therapy as well.

17-12.1.2 **Fluids.** Fluids should be administered to all individuals suffering from DCS unless suffering from the chokes (pulmonary DCS). Oral fluids (water, Gatorade-like drinks) are acceptable if the diver is fully conscious, able to tolerate them. If oral fluids cannot be tolerated by the patient, intravenous fluids should be administered. There is no data available that demonstrates a superiority of crystalloids (normal saline or Lactated Ringers solution) over colloids (such as Hetastarch compounds (Hespan or Hextend)) for DCS, but D5W (dextrose in water without electrolytes) should not be used. Since colloids are far more expensive than Lactated Ringers or normal saline, the latter two agents are the most reasonable choices at this time. The optimal amount of crystalloids/colloids is likewise not well-established but treatment should be directed towards reversing any dehydration that may have been induced by the dive (immersion diuresis causes divers to lose 250-500 cc of fluids per hour) or fluid shifts resulting from the DCS. Fluid overloading should be avoided. Urinary output, in the range of 0.5-1.0cc/kg/hour is evidence of adequate intravascular volume.

Chokes (pulmonary DCS) causes abnormal pulmonary function and leakage of fluids into the alveolar spaces. Aggressive fluid therapy may make this condition worse. Consult a DMO (or NEDU) for guidance.

17-12.1.3 **Anticoagulants.** Since some types of DCS may increase the likelihood of hemorrhage into the tissues, anticoagulants should not be used routinely in the treatment of DCS. One exception to this rule is the case of lower extremity weakness. Low molecular weight heparin (LMWH) should be used for all patients with inability to walk due to any degree of lower extremity paralysis caused by neurological DCS or AGE. Enoxaparin 30 mg, or its equivalent, administered subcutaneously every 12 hours, should be started as soon as possible after injury to reduce the risk of deep venous thrombosis (DVT) and pulmonary embolism in any paralyzed patients. Compression stockings or intermittent pneumatic compression are alternatives, although they are less effective at preventing DVT than LMWH.

17-12.1.4 **Aspirin and Other Non-Steroidal Anti-Inflammatory Drugs.** Routine use of anti-platelet agents in patients with neurological DCS is not recommended, due to concern about worsening hemorrhage in spinal cord or inner ear decompression illness. Use of these agents may also be risky in combat divers who may be required to return to action after treatment of an episode of DCS.

17-12.1.5 **Steroids.** Steroids are no longer recommended for the treatment of DCS. No significant reduction in neurological residuals has been found in clinical studies for DCS adjunctively treated with steroids and elevated blood glucose levels associated with steroid administration may actually worsen the outcome of CNS injury.

17-12.1.6 **Lidocaine.** Lidocaine is not currently recommended for the treatment of any type of DCS.

17-12.1.7 **Environmental Temperature.** For patients with evidence of brain or spinal cord damage, the current evidence recommends aggressive treatment of elevated body temperature. When treating victims of neurological DCS, whenever practical, hot environments that may cause elevation of body temperature above normal should be avoided. The patient's body temperature and vital signs should be monitored regularly.

17-12.2 Arterial Gas Embolism.

17-12.2.1 **Surface Oxygen.** Surface oxygen should be used for all cases of AGE as it is for DCS.

17-12.2.2 **Lidocaine.** Lidocaine has been shown to be potentially beneficial in the treatment of AGE. Current recommendations suggests a dosing end-point to achieve serum concentrations producing an anti-arrhythmic effect. An intravenous initial dose of 1 mg/kg followed by a continuous infusion of 2-4 mg/minute, will typically produce therapeutic serum concentrations. If an intravenous infusion is not established, intramuscular administration of 4-5 mg/kg will typically produce a therapeutic plasma concentration 15 minutes after dosing, lasting for around 90

minutes. Doses greater than those noted above may be associated with major side effects, including paresthesias, ataxia, and seizures. Therefore, Lidocaine should only be administered under the supervision of a DMO or other qualified physician.

17-12.2.3 **Fluids.** The fluid replacement recommendations for the treatment of AGE differ from those of DCS. Fluid replacement recommendations for AGE differ from DCS because the CNS injury in AGE may be complicated by cerebral edema, which may be worsened by an increased fluid load, thus causing further injury to the diver. If fluid replacement is conducted, colloids are probably the best choice due to their mechanism of action in maintaining intra-vascular volume and minimizing extra-vascular leakage. Particular care must be taken not to fluid overload the injured diver suffering from AGE by adjusting IV rates to maintain just an adequate urine output of 0.5cc/kg/hour. A urinary catheter should be inserted in the unconscious patient and urinary output measured.

17-12.2.4 **Anticoagulants.** Anticoagulants should not be used routinely in the treatment of AGE. As noted previously in paragraph 17-12.1.3 on anticoagulants in DCS, Enoxaparin 30 mg, or its equivalent, should be administered subcutaneously every 12 hours, after initial recompression therapy in patients suffering from paralysis to prevent deep venous thrombosis (DVT) and pulmonary embolism.

17-12.2.5 **Aspirin and Other Non-Steroidal Anti-Inflammatory Drugs.** Routine use of anti-platelet agents in patients with AGE is not recommended.

17-12.2.6 **Steroids.** Steroids are no longer recommended for the treatment of AGE. No significant reduction in neurologic residual has been shown with adjunctive treatment with steroids for AGE and elevated blood glucose levels associated with administration of steroids may worsen the outcome of CNS injury.

17-12.2.7 **Environmental Temperature.** For patients with evidence of brain or spinal cord damage, the current evidence recommends aggressive treatment of elevated body temperature. When treating victims of neurological DCS, whenever practical, hot environments that may cause elevation of body temperature above normal should be avoided. The patient's body temperature and vital signs should be monitored regularly.

17-12.3 **Sleeping and Eating.** The only time the patient should be kept awake during recompression treatments is during oxygen breathing periods at depths greater than 30 feet. Travel between decompression stops on Treatment Table 4, 7, and 8 is not a contra-indication to sleeping. While asleep, vital signs (pulse, respiratory rate, blood pressure) should be monitored as the patient's condition dictates. Any significant change would be reason to arouse the patient and ascertain the cause.

Food may be taken by chamber occupants at any time. Adequate fluid intake should be maintained as discussed in paragraph 17-8.3.1.

17-13 EMERGENCY MEDICAL EQUIPMENT

Every diving activity shall maintain emergency medical equipment that will be available immediately for use in the event of a diving accident. This equipment is to be in addition to any medical supplies maintained in a medical treatment facility and shall be kept in a kit small enough to carry into the chamber, or in a locker in the immediate vicinity of the chamber.

17-13.1 Primary and Secondary Emergency Kits. Because some sterile items may become contaminated as a result of a hyperbaric exposure, it is desirable to have a primary kit for immediate use inside the chamber and a secondary kit from which items that may become contaminated can be locked into the chamber only as needed. The primary emergency kit contains diagnostic and therapeutic equipment that is available immediately when required. This kit shall be inside the chamber during all treatments. The secondary emergency kit contains equipment and medicine that does not need to be available immediately, but can be locked-in when required. This kit shall be stored in the vicinity of the chamber.

The contents of the emergency kits presented here are not meant to be restrictive but are considered the minimum requirement. Additional items may be added to suit local medical preferences.

The Primary Emergency Kit is described in Table 17-8. The Secondary Emergency Kit is described in Table 17-9.

17-13.2 Portable Monitor-Defibrillator. All diving activities/commands shall maintain an automated external defibrillator (AED), preferably with heart rhythm visualization capability, from an approved Authorized Medical Allowance List (AMAL). Diving activities with assigned Diving Medical Officer are recommended to augment with a fully capable monitor defibrillator.

CAUTION **AED's are not currently approved for use under pressure (hyperbaric environment) due to electrical safety concerns.**

Table 17-8. *Primary Emergency Kit.*

Diagnostic Equipment
Stethoscope
Otoscope (Ophthalmoscope optional) and batteries
Sphygmomanometer (aneroid type only, case vented for hyperbaric use)
Reflex Hammer
Tuning Fork
Pinwheel
Tongue depressors
Thermometer/temperature measurement capability (non-mercury type)
Disposable exam gloves
Skin Marker
Pocket Eye Chart (Snellen)
Emergency Treatment Primary Survey Equipment and Medications
Oropharyngeal airways (#4 and #5 Guedel-type or equivalent)
Nasal airways (#32F and #34F latex rubber)
Lidocaine jelly (2%)
Self-Inflating Bag-Valve Mask (Disposable BVM)
Suction apparatus with appropriate suction tips
Tension pneumothorax relief kit with 3.25 inch, large-bore catheter on a needle
Cricothyrotomy kit
Adhesive tape (2 inch waterproof)
Elastic-Wrap bandage for a pressure bandage (2 and 4 inch)
Pressure dressing
Appropriate Combat Tourniquet
Trauma Scissors
Sterile 4X4s
Cravats
NOTE: One Primary Emergency Kit is required per chamber system, e.g. TRCS requires one. Additional Medical Equipment Authorized for Navy Use (ANU) in a chamber can be found in the Medical Equipment section of the ANU on the NAVSEA website. Contact the Senior Medical Officer at the Navy Experimental Diving Unit for any questions regarding specific pieces of medical equipment for use in the chamber.

Table 17-9. *Secondary Emergency Kit.*

Emergency Treatment Secondary Survey Equipment and Medications

- Alternative emergency airway device (recommend intubating laryngeal mask airway disposable LMA Fastrach™kit, size 4 – 5)
- Syringe and sterile water for cuff inflation (10 cc)
- Sterile lubricant
- Qualitative end-tidal CO_2 detector (colorimetric indicator)
- Chest tube
- BD Bard Parker Heimlich Chest Drain Valve (or other device to provide one-way flow of gas out of the chest)
- #11 knife blade and handle
- Sterile gloves (size 6 – 8)
- Surgical masks (4)
- 10% povidone-iodine swabs or wipes
- 1% lidocaine solution
- 21 gauge. 1 ½ -inch needles on 5 cc syringes (2)
- Curved Kelly forceps

Intravenous Infusion Therapy

- Catheter on a needle unit, intravenous (16 and 18 gauge - 4 ea)
- Adult interosseous infusion device (IO) for rapid vascular access
- Intravenous infusion sets (2 standard drip and 2 micro-drip)
- Syringes (5, 10 and 30 cc)
- Sterile needles (18, 22 and 25 gauge)
- Normal saline (1 liter bag (4))
- IV Start Kit (10% Povidone-Iodine swabs or wipes, 2 x 2 gauze sponges, Bioclusive dressing, ¾ -inch adhesive tape, phlebotomy tourniquet)
- Band aids
- Sam™ Splint

Miscellaneous

- Pulse Oximeter (Nonin 9500/8500 series)
- Nasogastric tube
- 60 cc Toomey Syringe (Optional)
- Urinary catheterization set with collection bag (appropriate size (12F–14F) Foley-type sterile catheters)
- Assorted suture material (0-silk with and without curved needles)
- Sharps disposable box
- Disposable Minor Surgical Tray can substitute for items listed below:
  - Straight and curved hemostats (2 of each)
  - Blunt straight surgical scissors
  - Needle driver
  - Sterile towels
  - Sterile gauze pads

NOTE 1: Whenever possible, preloaded syringe injection sets should be obtained to avoid the need to vent multi-dose vials or prevent implosion of ampules. Sufficient quantities should be maintained to treat one injured diver.

NOTE 2: One Secondary Emergency Kit is required per chamber system (i.e., TRCS requires one).

NOTE 3: A portable oxygen supply with an E cylinder (approximately 669 liters of oxygen) with a regulator capable of delivering 12 liters of oxygen per minute by mask/reservoir or 2 liters by nasal canula is recommended whenever possible in the event the patient needs to be transported to another facility.

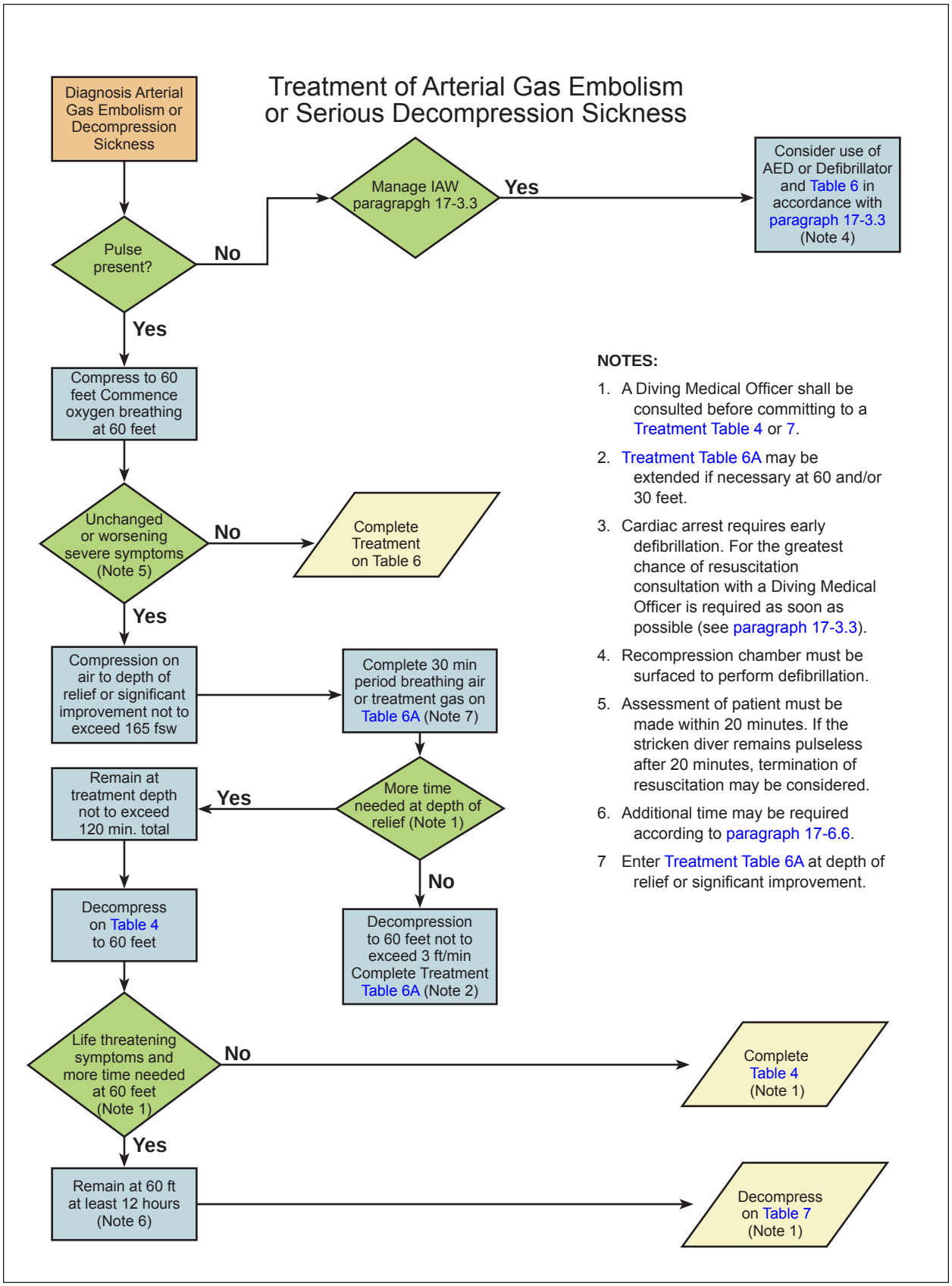

Figure 17-1. Treatment of Arterial Gas Embolism or Serious Decompression Sickness.

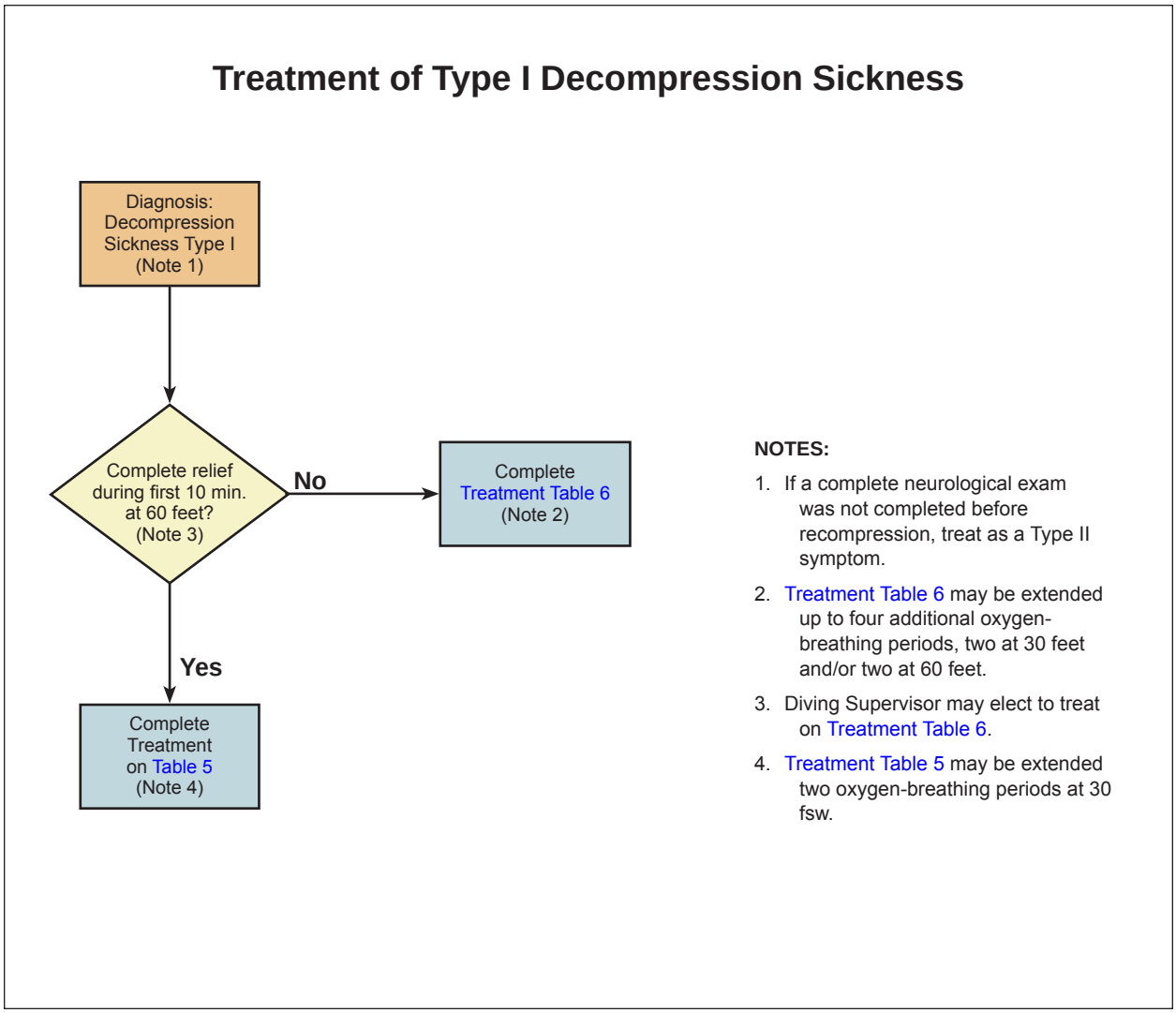

Figure 17-2. Treatment of Type I Decompression Sickness.

17-13.3 Advanced Cardiac Life Support (ACLS) Drugs and Equipment. All commands with chambers that participate in the local area bends watch shall maintain those drugs recommended by the American Heart Association for ACLS. These drugs need to be in sufficient quantities to support an event requiring Advanced Cardiac Life Support. These drugs are not required to be in every dive kit when multiple chambers/kits are present in a single command. In addition, medications for the treatment of anaphylaxis, which can occur related to marine life envenomation, including Epinephrine 1:1000 solution, Diphenhydramine IM or PO and Hydrocortisone Sodium Succinate IV will be maintained in adequate quantities to treat one patient.

Emergency medical equipment in support of ACLS includes cuffed endotracheal tubes with adapters (7-8 mm), malleable stylet (approx. 12" in length), laryngoscope with blades (McIntosh #3 and #4, Miller #2 and #3). Additional mechanical devices

for verification of endotracheal tube placement are also authorized, but not required (Toomey-type or 50cc catheter tip syringe or equivalent).

NOTE **Some vendors supply pre-packed ACLS kits with automated replenishment programs (examples of which can be found on the Naval Expeditionary Combat Command (NECC) AMAL).**

17-13.4 **Use of Emergency Kits.** Unless adequately sealed against increased atmospheric pressure (i.e., vacuum packed), sterile supplies should be re-sterilized after each pressure exposure; or, if not exposed, to pressure, the sterile supplies should be replaced at package expiration date. Drugs shall be replaced when their expiration date is reached. Not all drug ampules will withstand pressure.

NOTE **Stoppered multi-dose vials with large air volumes may need to be vented with a needle during pressurization and depressurization and then discarded.**

Both kits should be taken to the recompression chamber or scene of the accident. Each kit is to contain a list of contents and have a tamper evident seal. Each time the kit is opened, it shall be inventoried and each item checked for proper working order and then re-sterilized or replaced as necessary. Unopened kits are inventoried quarterly. Concise instructions for administrating each drug are to be provided in the kit along with current American Heart Association Advanced Cardiac Life-Support Protocols. In untrained hands, many of the items can be dangerous. Remember that as in all treatments **YOUR FIRST DUTY IS TO DO NO HARM.**

17-13.4.1 **Modification of Emergency Kits.** Because the available facilities may differ on board ship, at land-based diving installations, and at diver training or experimental units, the responsible Diving Medical Officer or Diving Medical Technician are authorized to augment the emergency kits to suit the local needs.

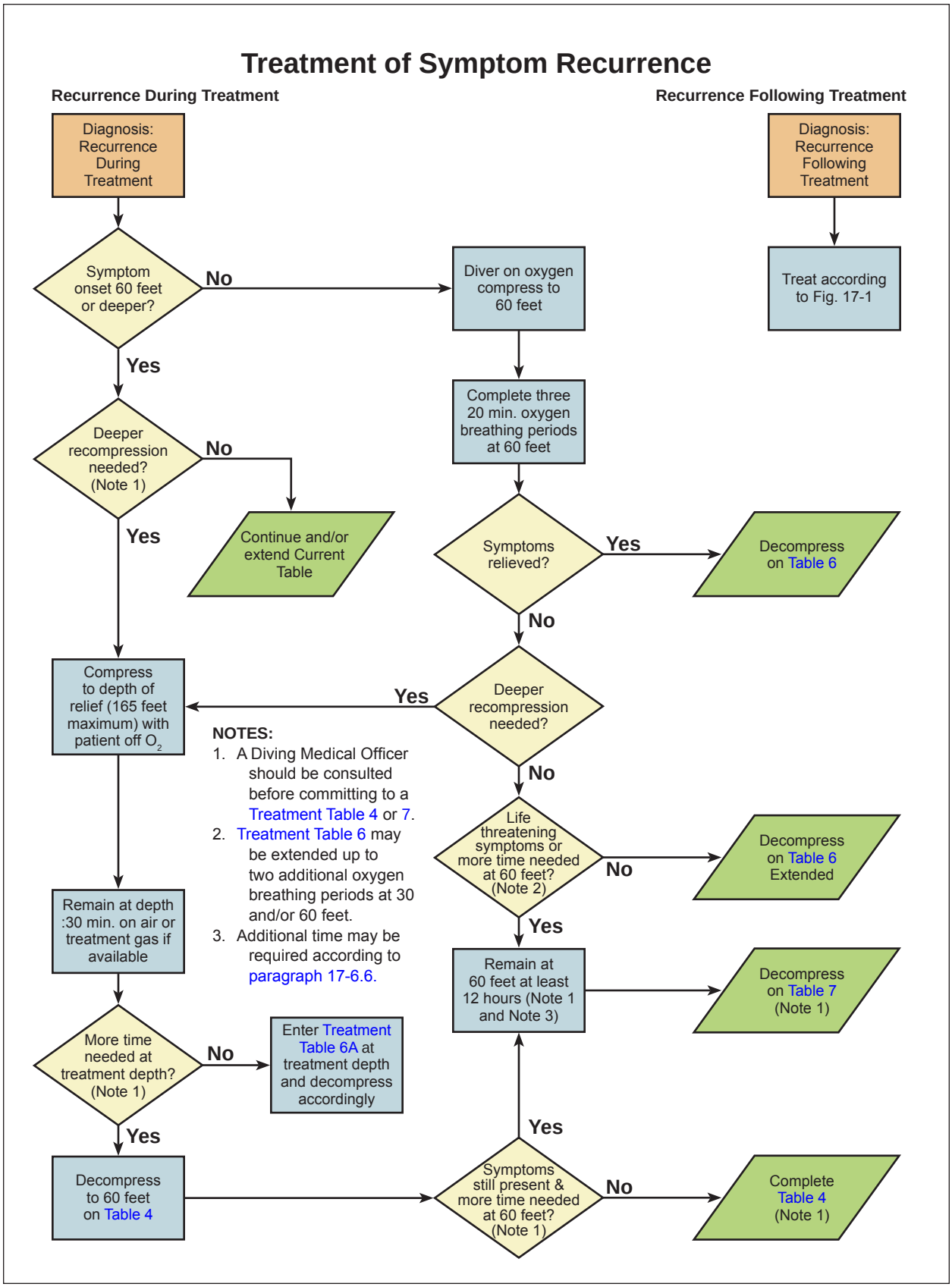

Figure 17-3. Treatment of Symptom Recurrence.

Treatment Table 5

1. Descent rate - 20 ft/min.
2. Ascent rate - Not to exceed 1 ft/min. Do not compensate for slower ascent rates. Compensate for faster rates by halting the ascent.
3. Time on oxygen begins on arrival at 60 feet.
4. If oxygen breathing must be interrupted because of CNS Oxygen Toxicity, allow 15 minutes after the reaction has entirely subsided and resume schedule at point of interruption (see paragraph 17-8.10.1.1)
5. Treatment Table may be extended two oxygen-breathing periods at the 30-foot stop. No air break required between oxygen-breathing periods or prior to ascent.
6. Tender breathes 100 percent O_2 during ascent from the 30-foot stop to the surface. If the tender had a previous hyperbaric exposure in the previous 18 hours, an additional 20 minutes of oxygen breathing is required prior to ascent.

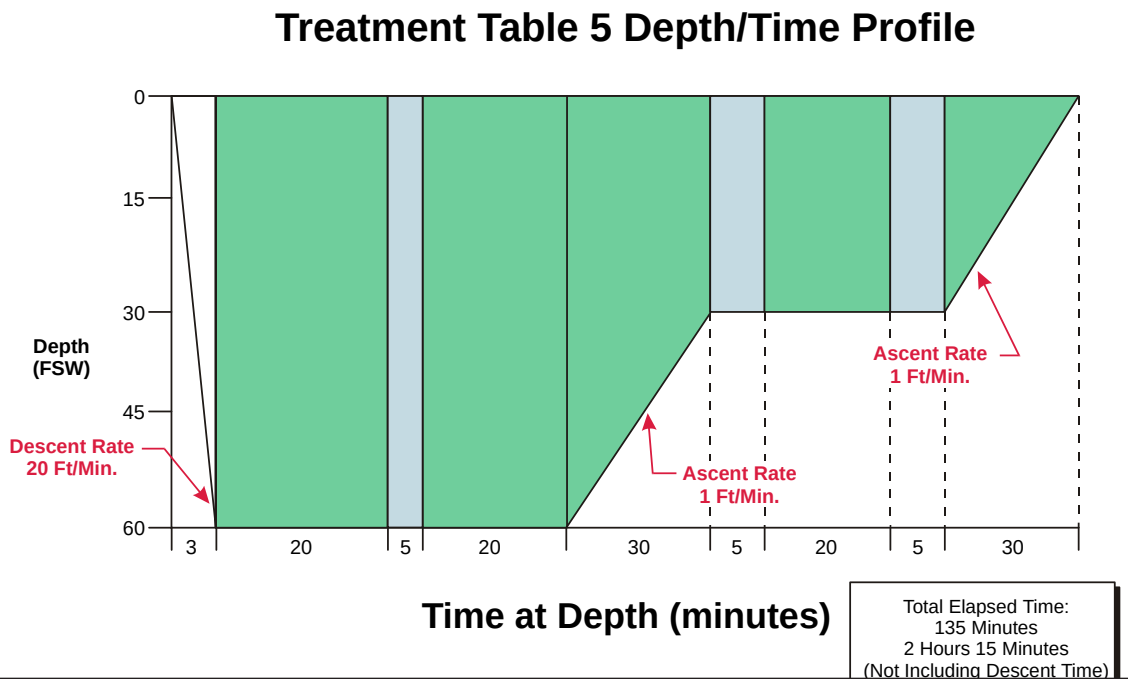

Figure 17-4. Treatment Table 5.

Treatment Table 6

1. Descent rate - 20 ft/min.
2. Ascent rate - Not to exceed 1 ft/min. Do not compensate for slower ascent rates. Compensate for faster rates by halting the ascent.
3. Time on oxygen begins on arrival at 60 feet.
4. If oxygen breathing must be interrupted because of CNS Oxygen Toxicity, allow 15 minutes after the reaction has entirely subsided and resume schedule at point of interruption (see paragraph 17-8.10.1.1).
5. Table 6 can be lengthened up to 2 additional 25-minute periods at 60 feet (20 minutes on oxygen and 5 minutes on air), or up to 2 additional 75-minute periods at 30 feet (15 minutes on air and 60 minutes on oxygen), or both.
6. Tender breathes 100 percent O_2 during the last 30 min. at 30 fsw and during ascent to the surface for an unmodified table or where there has been only a single extension at 30 or 60 feet. If there has been more than one extension, the O_2 breathing at 30 feet is increased to 60 minutes. If the tender had a hyperbaric exposure within the past 18 hours an additional 60-minute O_2 period is taken at 30 feet.

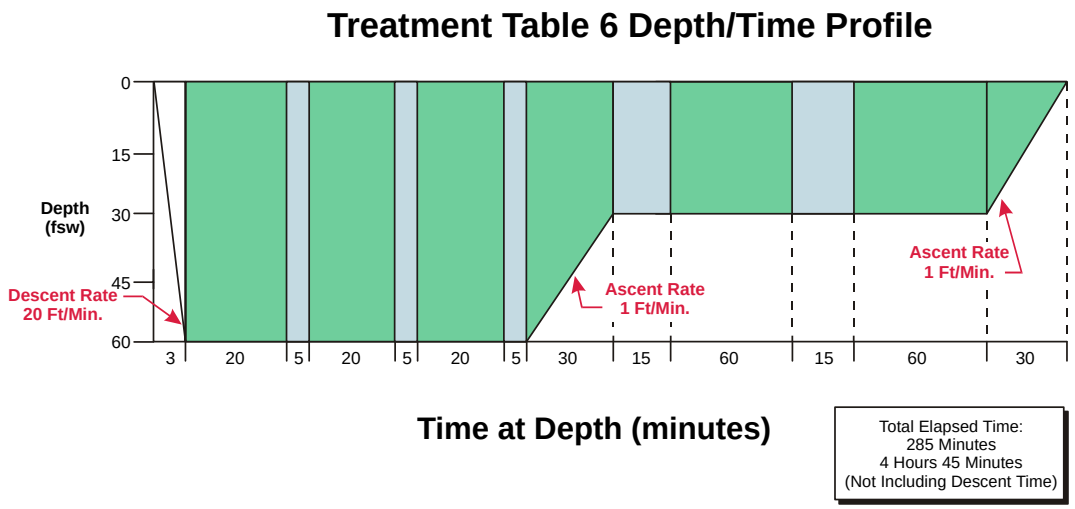

Figure 17-5. Treatment Table 6.

Treatment Table 6A

1. Descent rate - 20 ft/min.
2. Ascent rate - 165 fsw to 60 fsw not to exceed 3 ft/min, 60 fsw and shallower, not to exceed 1 ft/min. Do not compensate for slower ascent rates. Compensate for faster rates by halting the ascent.
3. Time at treatment depth does not include compression time.
4. Table begins with initial compression to depth of 60 fsw. If initial treatment was at 60 feet, up to 20 minutes may be spent at 60 feet before compression to 165 fsw. Contact a Diving Medical Officer.
5. If a chamber is equipped with a high-O_2 treatment gas, it may be administered at 165 fsw and shallower, not to exceed 3.0 ata O_2 in accordance with paragraph 17-8.9. Treatment gas is administered for 25 minutes interrupted by 5 minutes of air. Treatment gas is breathed during ascent from the treatment depth to 60 fsw.
6. Deeper than 60 feet, if treatment gas must be interrupted because of CNS oxygen toxicity, allow 15 minutes after the reaction has entirely subsided before resuming treatment gas. The time off treatment gas is counted as part of the time at treatment depth. If at 60 feet or shallower and oxygen breathing must be interrupted because of CNS oxygen toxicity, allow 15 minutes after the reaction has entirely subsided and resume schedule at point of interruption (see paragraph 17-8.10.1.1).
7. Table 6A can be lengthened up to 2 additional 25-minute periods at 60 feet (20 minutes on oxygen and 5 minutes on air), or up to 2 additional 75-minute periods at 30 feet (60 minutes on oxygen and 15 minutes on air), or both.
8. Tender breathes 100 percent O_2 during the last 60 minutes at 30 fsw and during ascent to the surface for an unmodified table or where there has been only a single extension at 30 or 60 fsw. If there has been more than one extension, the O_2 breathing at 30 fsw is increased to 90 minutes. If the tender had a hyperbaric exposure within the past 18 hours, an additional 60 minute O_2 breathing period is taken at 30 fsw.
9. If significant improvement is not obtained within 30 minutes at 165 feet, consult with a Diving Medical Officer before switching to Treatment Table 4.

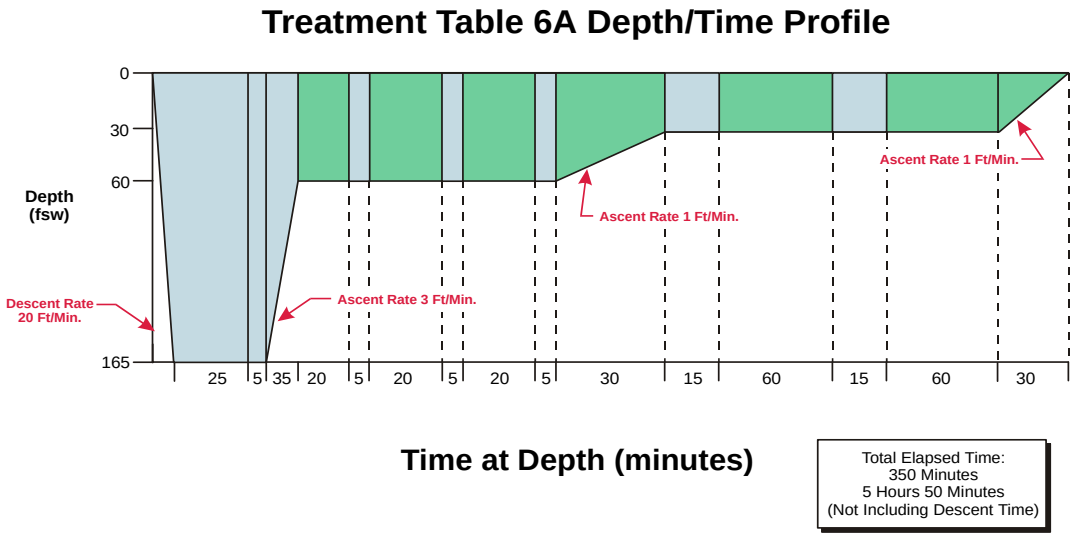

Figure 17-6. Treatment Table 6A.

Treatment Table 4

1. Descent rate - 20 ft/min.
2. Ascent rate - 1 ft/min.
3. Time at 165 feet includes compression.
4. If only air is available, decompress on air. If oxygen is available, patient begins oxygen breathing upon arrival at 60 feet with appropriate air breaks. Both tender and patient breathe oxygen beginning 2 hours before leaving 30 feet. (see paragraph 17-6.5).
5. Ensure life-support considerations can be met before committing to a Table 4. (see paragraph 17-8.10.1.1) Internal chamber temperature should be below 85° F.
6. If oxygen breathing is interrupted, no compensatory lengthening of the table is required.
7. If switching from Treatment Table 6A or 3 at 165 feet, stay a maximum of 2 hours at 165 feet before decompressing.
8. If the chamber is equipped with a high-O_2 treatment gas, it may be administered at 165 fsw, not to exceed 3.0 ata O_2. Treatment gas is administered for 25 minutes interrupted by 5 minutes of air.

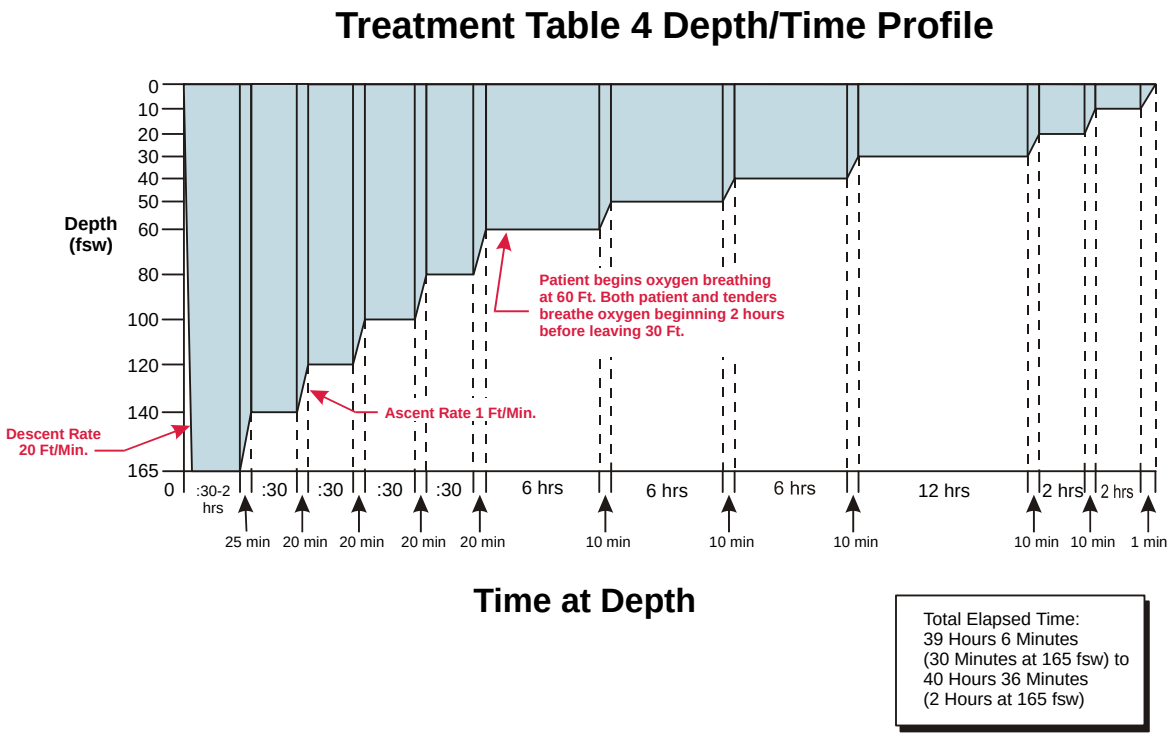

Figure 17-7. Treatment Table 4.

Treatment Table 7

1. Table begins upon arrival at 60 feet. Arrival at 60 feet is accomplished by initial treatment on Table 6, 6A or 4. If initial treatment has progressed to a depth shallower than 60 feet, compress to 60 feet at 20 ft/min to begin Table 7.
2. Maximum duration at 60 feet is unlimited. Remain at 60 feet a minimum of 12 hours unless overriding circumstances dictate earlier decompression.
3. Patient begins oxygen breathing periods at 60 feet. Tender need breathe only chamber atmosphere throughout. If oxygen breathing is interrupted, no lengthening of the table is required.
4. Minimum chamber O_2 concentration is 19 percent. Maximum CO_2 concentration is 1.5 percent SEV (11.4 mmHg). Maximum chamber internal temperature is 85°F (paragraph 17-6.5).
5. Decompression starts with a 2-foot upward excursion from 60 to 58 feet. Decompress with stops every 2 feet for times shown in profile below. Ascent time between stops is approximately 30 seconds. Stop time begins with ascent from deeper to next shallower step. Stop at 4 feet for 4 hours and then ascend to the surface at 1 ft/min.
6. Ensure chamber life-support requirements can be met before committing to a Treatment Table 7.
7. A Diving Medical Officer should be consulted before committing to this treatment table.

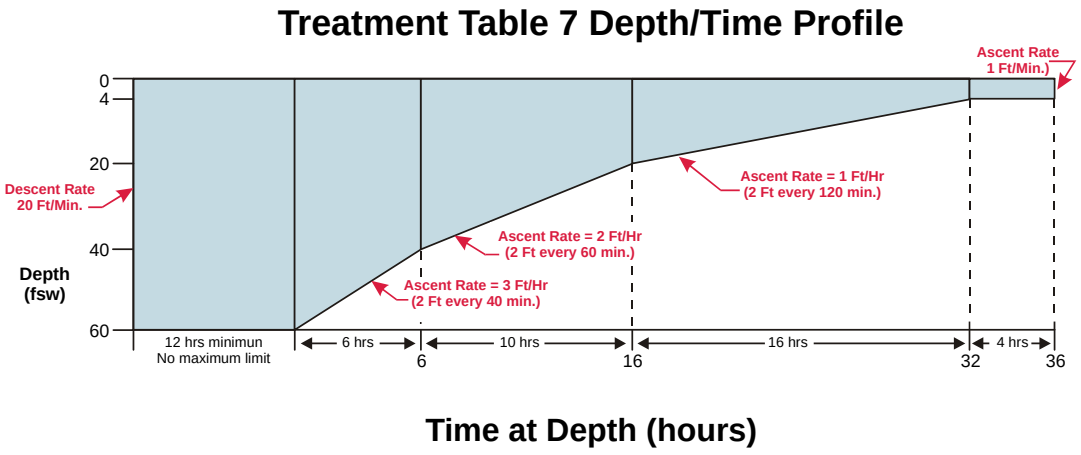

Figure 17-8. Treatment Table 7.

Treatment Table 8

1. Enter the table at the depth which is exactly equal to or next greater than the deepest depth attained in the recompression. The descent rate is as fast as tolerable.
2. The maximum time that can be spent at the deepest depth is shown in the second column. The maximum time for 225 fsw is 30 minutes; for 165 fsw, 3 hours. For an asymptomatic diver, the maximum time at depth is 30 minutes for depths exceeding 165 fsw and 2 hours for depths equal to or shallower than 165 fsw.
3. Decompression is begun with a 2-fsw reduction in pressure if the depth is an even number. Decompression is begun with a 3-fsw reduction in pressure if the depth is an odd number. Subsequent stops are carried out every 2 fsw. Stop times are given in column three. The stop time begins when leaving the previous depth. Ascend to the next stop in approximately 30 seconds.
4. Stop times apply to all stops within the band up to the next quoted depth. For example, for ascent from 165 fsw, stops for 12 minutes are made at 162 fsw and at every two-foot interval to 140 fsw. At 140 fsw, the stop time becomes 15 minutes. When traveling from 225 fsw, the 166-foot stop is 5 minutes; the 164-foot stop is 12 minutes. Once begun, decompression is continuous. For example, when decompressing from 225 feet, ascent is not halted at 165 fsw for 3 hours. However, ascent may be halted at 60 fsw and shallower for any desired period of time.
5. While deeper than 165 fsw, a helium-oxygen mixture with 16-36 percent oxygen may be breathed by mask to reduce narcosis. A 64/36 helium-oxygen mixture is the preferred treatment gas. At 165 fsw and shallower, a HeO_2 or N_2O_2 mix with a ppO_2 not to exceed 3.0 ata may be given to the diver as a treatment gas. At 60 fsw and shallower, pure oxygen may be given to the divers as a treatment gas. For all treatment gases (HeO_2, N_2O_2, and O_2), a schedule of 25 minutes on gas and 5 minutes on chamber air should be followed for a total of four cycles. Additional oxygen may be given at 60 fsw after a 2-hour interval of chamber air. See Treatment Table 7 for guidance. If high O_2 breathing is interrupted, no lengthening of the table is required.
6. To avoid loss of the chamber seal, ascent may be halted at 4 fsw and the total remaining stop time of 240 minutes taken at this depth. Ascend directly to the surface upon completion of the required time.
7. Total ascent time from 225 fsw is 56 hours, 29 minutes. For a 165-fsw recompression, total ascent time is 53 hours, 52 minutes, and for a 60-fsw recompression, 36 hours, 0 minutes.

Depth (fsw)	Max Time at Initial Treatment Depth (hours)	2-fsw Stop Times (minutes)
225	0.5	5
165	3	12
140	5	15
120	8	20
100	11	25
80	15	30
60	Unlimited	40
40	Unlimited	60
20	Unlimited	120

Figure 17-9. Treatment Table 8.

Treatment Table 9

1. Descent rate - 20 ft/min.
2. Ascent rate - 20 ft/min. Rate may be slowed to 1 ft/min depending upon the patient's medical condition.
3. Time at 45 feet begins on arrival at 45 feet.
4. If oxygen breathing must be interrupted because of CNS Oxygen Toxicity, oxygen breathing may be restarted 15 minutes after all symptoms have subsided. Resume schedule at point of interruption (see paragraph 17-8.10.1.1).
5. Tender breathes 100 percent O_2 during last 15 minutes at 45 feet and during ascent to the surface regardless of ascent rate used.
6. Patient may breathe air or oxygen during ascent.
7. If patient cannot tolerate oxygen at 45 feet, this table can be modified to allow a treatment depth of 30 feet. The oxygen breathing time can be extended to a maximum of 3 to 4 hours.

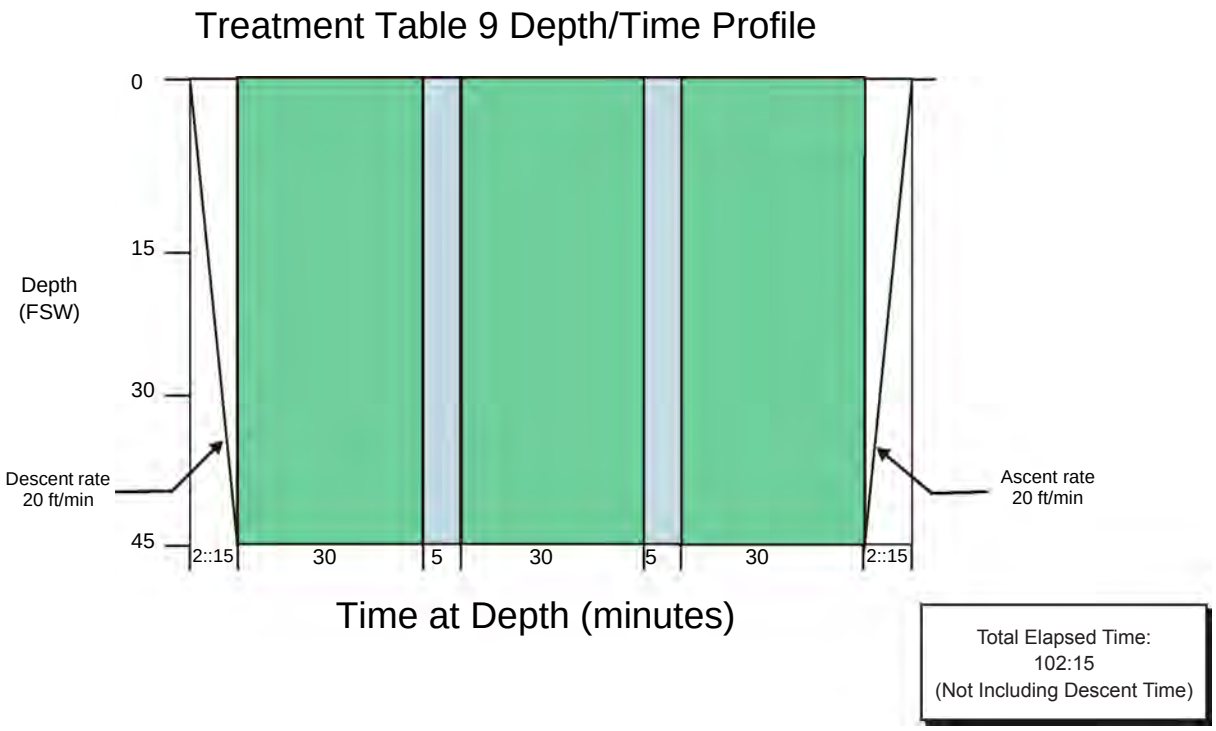

Figure 17-10. Treatment Table 9.

Air Treatment Table 1A

1. Descent rate - 20 ft/min.
2. Ascent rate - 1 ft/min.
3. Time at 100 feet includes time from the surface.

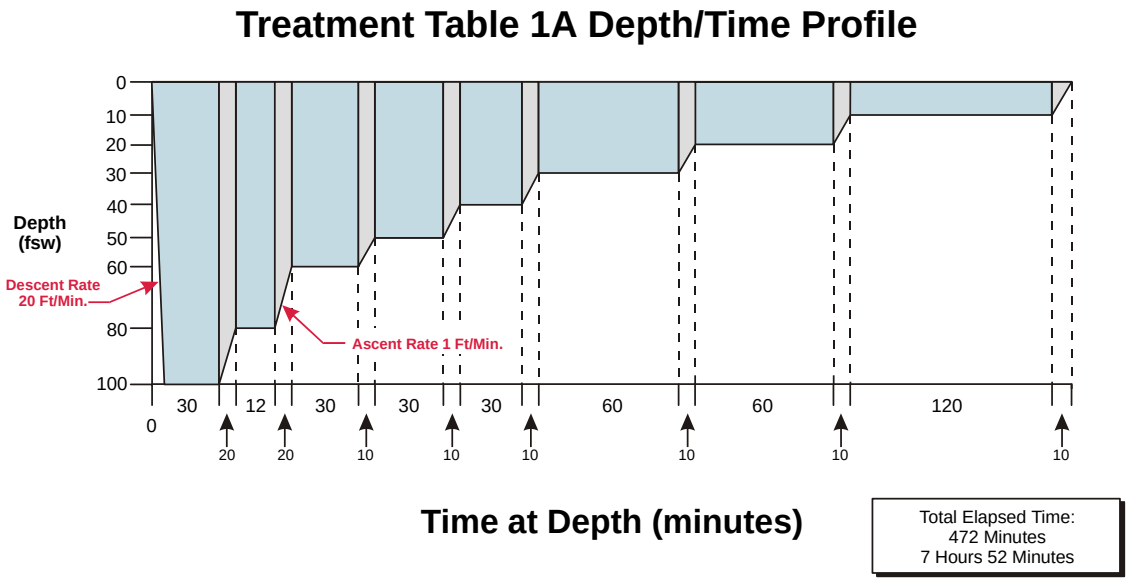

Figure 17-11. Air Treatment Table 1A.

Air Treatment Table 2A

1. Descent rate - 20 ft/min.
2. Ascent rate - 1 ft/min.
3. Time at 165 feet includes time from the surface.

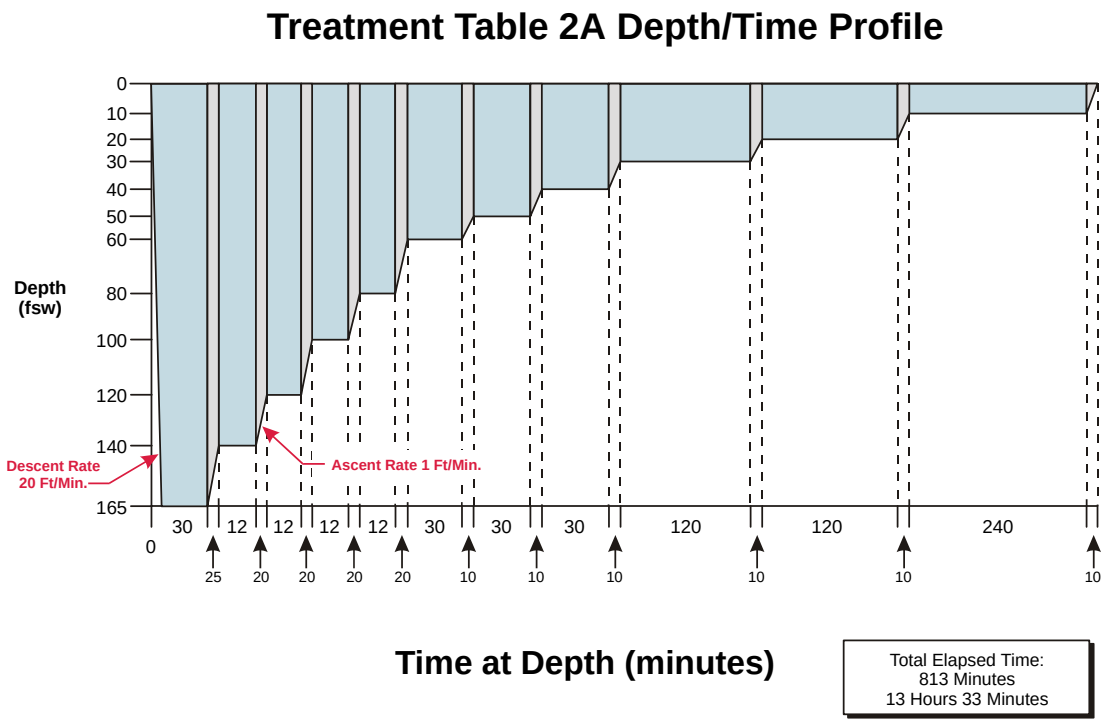

Figure 17-12. Air Treatment Table 2A.

Air Treatment Table 3

1. Descent rate - 20 ft/min.
2. Ascent rate - 1 ft/min.
3. Time at 165 feet-includes time from the surface.

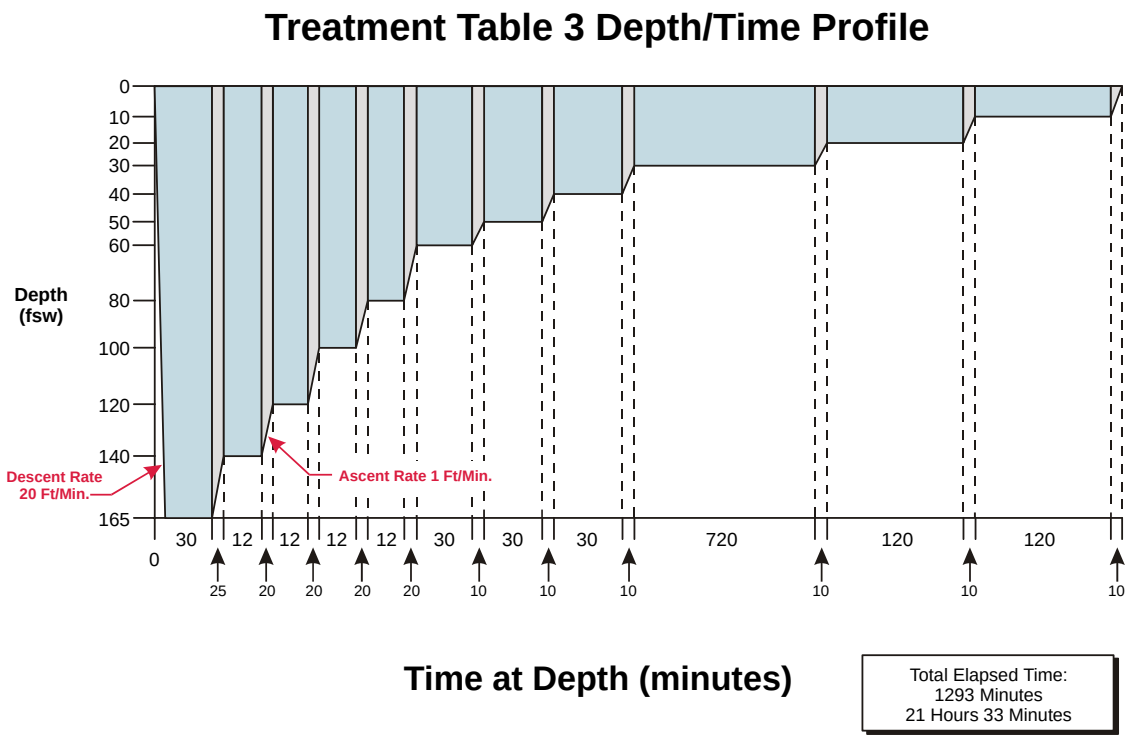

Figure 17-13. Air Treatment Table 3.