

Certified Diver Medic

Approved Training Course Outline



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This content outline addresses the core areas of diving medicine and operations and the scope of information that should be taught. This outline represents a standardized and orthodox curriculum in diving accident management. It should equip the student to conduct basic treatment if operating independently, and to work with a knowledgeable physician if contact is made. No attempt is made in this outline to give weight or relative importance to the various sections, as this will vary according to the needs of different students and their prior knowledge and training.

1. Introduction

- a. Preview of skill and knowledge objectives, major topics in course
- b. Preview of demonstrations and sham treatments
- c. Attendance, grading, evaluation and examination policies
- d. Review of gas laws, diving physics and physiology (optional)

2. Role of the Medic

- a. Responsibilities
 - i. Responsibilities as a diver (where applicable)
 - follow safe practice standards
 - set example
 - teach and instruct others
 - ii. Responsibilities as a medic
 - emergency care, basic life support, stabilize
 - report accidents and treatment to medical authority
 - perform tasks and give aid as directed by proper authority
 - in absence of orders, carry out treatment and triage according to training and ability
 - encourage fitness in diving community
 - maintain proficiency in diving and emergency medicine
 - keep accurate, informative records (send with patient as applicable)
- b. Liaison with others
 - i. knowledgeable physicians in medic's own area - protocols, standing orders
 - ii. local hospitals and chamber facilities
 - iii. local EMS system
 - iv. law enforcement, fire departments, U.S. Coast Guard, etc.
 - v. communications system
 - vi. Divers Alert Network (DAN)

3. Records and Fitness (variable according to medic's status, industry, and employer)

- a. Baseline records
 - i. Knowledge of disqualifying conditions (permanent and temporary)
 - ii. Review of diver's medical history or previous physicals
 - iii. Record family and emergency data
 - iv. Routine exam (basic)
 - vital signs
 - ENT
 - heart and lungs
 - b. Pre-dive evaluation (where applicable)
 - i. current or recent medical conditions
 - ii. current drugs or medications
 - iii. recent lifestyle or personal habits
 - iv. recent dive history
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- v. brief physical exam (vital signs, ENT, heart and lungs)
 - c. Post-dive evaluation (where applicable)
 - i. dive and decompression history
 - ii. brief physical
 - iii. neuro and mental status evaluation

4. Decompression Sickness (DCS)

- a. Pathophysiology
 - i. Separation of inert gas bubbles from soluble phase to gas phase
 - intravascular bubbles
 - tissue/extravascular bubbles
 - ii. Bubble effects
 - direct – possible obstructed blood flow, ischemia; possible effects on tissue, neural tissue, local chemical mediators
 - indirect – hematological reactions to bubble surface, platelet and enzyme effects, capillary permeability, hemoconcentration and edema, hypovolemia
 - iii. Complications
 - cardiopulmonary – bubbles clogging pulmonary artery, right-to-left shunting of bubbles, tachypnea, possible congestion of epidural veins, reduced cardiac output
 - neurological – possible cerebral and spinal emboli
 - b. Predisposing factors – concept of lowered resistance to DCS
 - i. dehydration
 - ii. poor fitness
 - iii. illness and hangover
 - iv. role of exercise during dive and decompression
 - v. age
 - vi. temperature variances
 - vii. rapid gas switching
 - c. Signs and Symptoms
 - i. “Type I” – minor
 - pain only – joint pain (not central or peripheral nervous system), normal neuro exam
 - skin – itching, mild rash
 - ii. “Type II” – serious
 - sensory abnormalities, radicular pain
 - weakness, paralysis
 - vestibular symptoms – hearing, balance
 - mood, intellect, personality changes
 - visual symptoms
 - i. Vague, generalized symptoms
 - flu-like symptoms
 - marked fatigue
 - headache, disorganized, difficulty concentrating
 - DCS as “great imitator” – may mimic everyday illness
 - role of test of pressure – done where symptoms don’t seem to indicate decompression sickness, neuro is normal
 - need for suspicion, treating doubtful case
 - d. Treatment
 - i. Treatment tables
 - USN tables – 5, 6, 6-A, 7, modified 4
 - others – Royal Navy 71 and 72, Comex 30 and 30-A, Lambertsen 7-A, USN and other saturation tables
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- concept that treatment tables are specialized decompression, treatment table is dose of medicine (oxygen) different tables represent treatments for variable severity of DCS
 - ii. Treatment flow chart
 - Field Guide for Diver – Medic with captions, notes and comments
 - other suitable, integrated flow chart
 - iii. Fluids and drugs
 - importance of hydration – oral or IV fluids, good urine output
 - *possible* role of drugs, usual doses (Valium, Decadron, Dextran, etc)
 - emphasize basic treatment for bends is pressure, oxygen, fluids, and time; proper role of medications is debated; given by medic on direct or standing order
 - iv. In-water oxygen treatment (controversies) – as described in Diving and Subaquatic Medicine by Edmonds, Lowry, and Pennefather (optional)
 - v. Role of the monoplace hyperbaric chamber, limitations, etc (optional)

5. Barotrauma

- a. Squeeze
 - i. Sinus – signs and symptoms, need approximately 3-10 days to resolve; possible secondary sinus infection
 - ii. Middle ear – signs and symptoms; perforation of eardrum; possible secondary otitis media other squeeze – suit, “reverse” squeeze, etc
 - iii. Inner ear (differential diagnosis)
 - iv. Other squeeze – suit, “reverse” squeeze, etc.
- b. Lung overpressure
 - i. review usual causes- rapid ascent, pressure reduction and wave surge, panic and breath holding; lung diseases
 - ii. pathology – rupture alveolus, expanding air transects to pleural surface, or tracks along tissue planes, or enters pulmonary circulation and left ventricle
 - iii. Mediastinal emphysema
 - air tracks along lung tissue planes and ruptures into mediastinal space or pericardial sac
 - signs and symptoms – midchest pain or pressure, resonant or crunching heart sounds, cardiac tamponade (distended veins, narrow pulse pressure, low blood pressure and cardiac output), possible mild cyanosis, irregular pulse
 - treatment – varies from none (observation), to breathing oxygen, to recompression (seldom), according to patient’s status and symptoms
 - iv. Subcutaneous emphysema
 - burst upper lung leads to air tracking along upper bronchi, into tissue around neck and clavicle
 - signs and symptoms – pain or ache in neck or upper chest “sore throat”, pain with swallowing, change in voice, palpable air under skin (“rice crispies”)
 - treatment – same as 3.c (recompression seldom needed, minimal depth only)
 - v. Pneumothorax
 - expanding air ruptures through lung surface; free air present in chest cavity, outside lung
 - small leak and/or occurring near surface will be simple pneumothorax

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- if not near surface, any simple pneumothorax during decompression may become a tension pneumothorax
 - signs and symptoms of simple and tension pneumothorax same as from non-diving causes (chest pain, splinting, dyspnea, shortness-of-breath, cyanosis, tracheal deviation, hypotension diminished breath sounds); *improves with compression*
 - treatment of simple pneumothorax – varies from observation only to giving oxygen (recompression seldom needed)
 - treatment of tension pneumothorax:
 - compression deeper, or recompress to depth of significant relief
 - possible needle puncture to relieve pressure
 - after compression, use of saturated schedule and oxygen breathing to resorb trapped air (avoids chest wall puncture)
 - insertion of indwelling cannula or chest tube with seal or one-way valve
 - regardless of treatment, hold at depth of relief until stabilized before decompressing
 - vi. Cerebral arterialair embolism
 - expanding alveolar air enters tributaries of pulmonary vein, transported to left heart, into aorta and cerebral arteries, causing stroke-like injury
 - signs and symptoms – usually rapid and dramatic; unconsciousness; convulsion; apnea; paralysis and hemiparesis; hemiplegia; hemoptysis
 - possible occurrence of both air embolism and pneumothorax
 - treatment standards

6. Oxygen Toxicity

- a. A. Current, generally accepted concepts of oxygen toxicity (biochemical, neurotransmitters, physiologic)
- b. Concepts of oxygen limits
 - i. Lung vs. CNS
 - ii. Dry vs. in-water, working vs. at-rest
- c. Pulmonary toxicity
 - i. Disruption of alveolar surfactant, small airway and alveolar closure, lung edema, disrupts gas transfer by lung
 - ii. Results are similar to pneumonia or respiratory distress syndrome
 - iii. Signs and symptoms
 - iv. varies from mild tracheal irritation, cough, painful breathing, dyspnea, cyanosis, death
 - v. lungs sound relatively normal until advanced
 - vi. Treatment – lower pO₂ unless end of treatment or decompression is near
 - vii. UPTD (optional)
 - concept – amount of damage from 100% oxygen at 1 ATA for one minute
 - typical UPTD dose causing 10%, 20%, loss of vital capacity, relationship to usual treatment tables
 - UPTD is only additive; role of air breaks in permitting high-dose oxygen treatment
- d. CNS toxicity
 - i. state of cerebral irritability

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- ii. sign and symptoms – restlessness, irritability, twitching, tingling, visual symptoms, nausea, hiccups, convulsion; “VENTED”
 - iii. management – remove mask/lower pO₂, protect from harm during seizure, resume treatment fifteen minutes after resolution

Optional Material

The following are examples of subject matter which the instructor may wish to include in the basic diving medicine training, refresher classes, or both. Suitability for these options will depend on previous training, diving location, ability to learn quickly, employer and industry, and interest in peripheral material. The instructor should try to keep the training relevant to the needs and abilities of each class

Options should not be included at the expense of core lecture material, practice sessions and sham treatments. The instructor should be satisfied that the class is mastering basic material and save options for students with special needs, or where the pace of instruction is clearly moving faster than expected, or allow extra time in scheduling the entire course

1. Marine Hazards

- a. common marine hazards in the local area
- b. signs, symptoms, acute treatment of each

2. Environmental Accidents

- a. emergency management of near-drowning
- b. emergency management of hyper-, hypo-thermia

3. Carbon Dioxide Toxicity

4. Tropical Medicine

5. Ear Hygiene, otitis externa

6. Review of basic life support, non-diving emergency medicine

7. Review of gas laws, diving physics and physiology

Concerning review material, the instructor may prefer to utilize assignments sent to the students prior to class, particularly for diving physics and gas laws

Knowledge Objectives

These knowledge and skills objectives indicate what each student is expected to know upon successful completion of the Diving Medicine Module 16. End of course testing policies are left to the discretion of the instructor staff. Testing should, however, be flexible enough to assess each individual fairly, rigorous enough to ensure an adequate understanding of course content and how it will be put into practice, and adequately balanced between didactic and practical skills. Regarding the latter, DMT training should be field-oriented, practical, and directed towards hands-on treatment of diving accidents. Academic teaching should be sufficient that the student understands the correctness of what he is to do, but should not cause confusion or doubt. Matters of scientific controversy or research interest may be introduced for variety and stimulation, but, as much in diving medicine is not fully understood even by experts, the goal should be standardized and orthodoxy at the medic or paramedic level. Where the instructor has developed strong personal preferences or practices, they should point this out and present other viewpoints, when appropriate.

In organizing and scheduling the course, the instructor should keep these learning goals in mind regarding the objectives and be flexible enough to satisfy the needs of each class. After the

period of instruction and rigorous, balanced, examination process, the student should satisfy the instructor that they understands the following:

1. Role of the Medic

- a. similarities and differences compared to non-diving
- b. record keeping
- c. relationship to diving physicians and others in the medical support system

2. Medical/Fitness to Dive

- a. baseline, pre- and post-dive exams
- b. disqualifying conditions, temporary and permanent

3. Decompression sickness

- a. possible predisposing conditions, concept of susceptibility to an environmentally-caused disease
- b. physiologic events leading to DCS, initial and later phases of DCS, hematologic and other effects of tissue and intravascular bubbles
- c. common and unusual signs and symptoms of DCS, mild (Type I) and serious (Type II) DCS, major forms of DCS (skin, vestibular, joint, CNS, pulmonary, saturation)
- d. the test of pressure and its proper use in approaching the uncertain case of DCS
- e. concept of treatment table as a treatment or medication (ie, a dose); tables USN 5, USN 6, USN 6-A, Royal Navy 71 and 72, Comex 30 and 30-A, saturation tables; usual application of the treatment tables; follow-up after treatment
- f. the flow chart from Field Guide for the Diver Medic (or similar chart) and ability to sketch or form a general treatment plan and various options
- g. the role of drugs in treatment (adjunctive), fluids, and those which diving physicians may use

4. Barotrauma

- a. anatomy and physiology of the air-containing spaces, mechanism of squeeze and pulmonary over-inflation (air embolism, pneumothorax, mediastinal emphysema, subcutaneous emphysema)
- b. the principle signs and symptoms of squeeze and overpressure injuries and distinguishing features between them
- c. routine and emergency management of squeeze and over-pressure understanding of tension pneumothorax as encountered while diving

5. Oxygen Toxicity

- a. simple concepts of causes of oxygen toxicity, signs and symptoms of CNS and pulmonary toxicity, usual CNS and pulmonary oxygen limits
- b. understanding the difference between oxygen percentage and oxygen partial pressure
- c. UPTD general concept and that is additive, concept of air breaks and role in reducing oxygen toxicity problems

Skills Objective

The student should satisfy the instructor that they have mastered the following:

1. Physical Examinations

- a. an adequate emergency baseline assessment, obtain and evaluate vital signs, provide basic life support, properly use basic equipment such as pen light, stethoscope, blood pressure cuff, otoscope
- b. use of the otoscope in performing a simple ear exam
- c. ability to keep adequate records of exams and treatments

2. Neurological Exams (student or instructor posing as patient)

- a. the ability to do an adequate field neuro exam covering; state of consciousness and
- b. intellectual functions, cranial nerves, sensory function, motor function, and balance/coordination
- c. ability to do exam inside and outside chamber and as follow-up to treatment

3. Sham Treatments (student or instructor posing as accident victim)

- a. ability to elicit symptoms of simulated DCS or barotrauma case
- b. ability to discover signs of same
- c. ability to use basic medical kit and equipment properly, at surface and in chamber
- d. ability to function effectively while in chamber
- e. ability to formulate and conduct a basic treatment plan
- f. ability to keep adequate records and make accurate reports to a diving physician or other appropriate authority
- g. ability to observe and maintain proper oxygen limits, recognize and manage simulated symptoms of toxicity

Chamber Operations Module

The usual role of a DMT is to attend to the medical needs of the injured diver. Therefore, the primary goal of DMT training is providing emergency medical care in and outside the chamber; there is no primary intent to make the medic an expert on chamber operations or related hardware

Since chambers in many areas are thinly staffed, perhaps by persons of unknown competence, the major goal of the Chamber Operations Module is to enable the DMT to see to the safety of himself and his patient while in the chamber. Secondly, he is taught the rudiments of hands-on chamber operations, time-keeping, dive recording, pre- and post-dive checklists, and the conduct of a simple chamber treatment

Content Outline and Knowledge Objectives are presented the same as in the Diving Medicine Module. A Sample Course Schedule is not given, as the additional time required will vary. Much of chamber operations can be incorporated into the Medical Module (e.g, oxygen analyzers with oxygen toxicity, chamber ventilation with sham treatments) and a few hours of lecture will suffice for the rest. As with Diving Medicine, much will probably depend on the individual instructor and the needs of each class

Knowledge Objectives

The student should be able to demonstrate clear understanding of the following:

1. Chamber Safety

- a. The main codes and standards relating to chamber operations, safe handling of gases used in diving, and sources of information
- b. The factors necessary for occurrence of chamber fires, extreme hazard of chamber fires, oxygen percentage versus oxygen partial pressure, various

ignition sources, flammability of ordinary materials in chambers, zone of combustion, need for proper clothing and oil-free environment

- c. The role of electrical systems as possible sources of fire, electrical failure as threat to safe operation of chamber
- d. The various ways fire can be extinguished
- e. The methods for maintaining safe levels of oxygen and carbon dioxide, ventilation requirements, use of BIBS, use of analyzers, dangers and sources of carbon monoxide
- f. The need to protect ears from high noise levels, safe use of medical equipment in chamber, avoiding injury to medic and patient
- g. The function of carbon dioxide scrubbers, avoidance of caustic injury

2. Chambers

- a. The main general types of chambers and main uses for each
- b. The basics of chamber construction, basic terminology of chamber operations
- c. An understanding of gas requirements for typical treatments, backup supplies, emergency procedures for supply failure; definition of treatment and emergency gases

3. Pre-Dive Checklist

- a. Prepare a basic checklist and show how each item relates to the safe operation of the chamber. Student should not omit any significant item.

4. Post-Dive Checklist

- a. The essential steps necessary to ensure the chamber is left ready for safe use, properly equipped and supplied

5. Chamber

- a. The ability to perform the essential functions of chamber operation and conduct a simulated treatment under supervision

Appendix I

Essential Invasive Skills (*Required* for DMT certification)

1. Intravenous access
 - b. Fluid infusions
 - c. Drug administration
 - d. Blood draws
2. Intramuscular injection
3. Subcutaneous injection
4. Insertion of urinary catheter
5. Insertion of nasogastric/orogastric tube
6. Manual or battery powered oropharynx/orogastric suction
7. Airway control; one or more of the following:
 - a. Laryngeal mask airway
 - b. Pharyngeal-tracheal lumen
 - c. Endotracheal intubation
 - d. Needle cricothyroidotomy
8. Chest decompression capability; one or both of the following:
 - a. Pneumothorax needle
 - b. Chest tube
9. Basic Life Support

Valuable Optional Skills (*Not required* for DMT certification)

1. Use of the 'Easy IO Drill'
2. Simple suture repairs or alternate of wound closure option, e.g.,
 - a. Dermagel / Dermabond
 - b. Quickclot
 - c. Celox gauze
3. Splinting of simple dislocations and fractures
4. Advanced Cardiac Life Support
5. CO2 scrubber installation for chamber under pressure
6. **Operation of a CO2 analyzer**