Certified Diver Medic

Approved Training Course Outline

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NBDHMT Approved Course Outline

This content outline addresses the core aspects of diving medicine and related operations. It represents the scope of information that should be taught. The outline summarizes a standardized curriculum in diving accident management. It is designed to prepare the prospective DMT to evaluate and initiate treatment of diving accidents and injuries.

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 authorities
        - perform tasks and give aid as directed by proper authorities
        - in absence of specific orders, carry out treatment and triage according to training and ability
        - encourage fitness in diving community
        - maintain proficiency in diving (where applicable) and emergency medicine
        - keep accurate, informative records (send with patient as applicable)

b. Liaison with others
    i. Knowledgeable physicians in medic's own company/region- 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 prescribed drugs or medications
    iii. Recent lifestyle or personal habits
    iv. Recent dive history
    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. Evolution of inert gas 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
        - indirect – hematological reactions to bubble surface, platelet and other effects, capillary permeability, hemoconcentration and edema, hypovolemia
    iii. Complications
        - cardiopulmonary – bubbles clogging pulmonary artery, right-to-left shunting of bubbles, tachypnea, reduced cardiac output
        - neurological – possible cerebral and spinal emboli

b. Predisposing factors – concept of lowered resistance to DCS
    i. Dehydration
    ii. Poor physical fitness
    iii. Related illnesses
    iv. Role of exercise during dive and decompression
    v. Increasing age
    vi. Temperature variances
    vii. Rapid inert gas switching

c. Signs and Symptoms
    i. "Type I" – minor
        - pain only – joint pain (rule out central or peripheral nervous system involvement),
        - skin – itching, mild rash, 'cutis marmarata'
    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
        - unusual fatigue
        - headache, difficulty concentrating
        - DCS as "great imitator" – may mimic everyday illnesses
        - role of test of pressure – done where symptoms don't seem to indicate decompression sickness, neuro is normal
        - index of suspicion

d. Treatment
    i. Treatment tables
        - USN tables – 5, 6, 6-A, 7, 9 and saturation decompression sickness table
        - Comex 30

- concept that treatment tables are specialized decompressions, treatment table is dose of medicine (oxygen). Respective treatments for variable severity of DCS

ii. 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; role of medications is debated; given by medic on direct or standing order

iii. In-water oxygen treatment (controversies)

iv. 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
    - lung trauma, leads to air tracking along upper bronchi, into and above clavicle
    - signs and symptoms – pain 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
    - if not near surface, any pneumothorax during decompression may become a tension pneumothorax
    - signs and symptoms of simple and tension pneumothorax same as 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 100% oxygen (recompression seldom needed)
- treatment of tension pneumothorax:
  - recompression to depths of significant relief
  - needle decompression
  - after compression, use of saturation decompression 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

vi. Cerebral arterial air 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 concurrent air embolism and pneumothorax
- treatment standards

6. Oxygen Toxicity

a. Current and generally accepted concepts of oxygen toxicity

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-done oxygen treatment
- Clinically, an historic concept, rarely incorporated into modern treatment decisions

d. CNS toxicity

i. state of cerebral irritability

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 and from point of interuption

Optional Material
The following are examples of subject matter which instructors may wish to include in basic diving medicine training, refresher classes, or both. Suitability for these options will depend on previous training, geographic location, ability to learn quickly, employer and industry, and interest in peripheral material. Instructors 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
    b. signs, symptoms, acute treatment

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, instructors 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. Specifically, it is expected that elements of patient evaluation and invasive skills training will be conducted in a hyperbaric chamber. 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, instructors 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 staff that they understand 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, USN 9, Comex 30 and 30-A, saturation tables; usual application of the treatment tables; follow-up after treatment
f. the role of drugs and fluids

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 pneumothorax and tension pneumothorax

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

Skills Objective
The student should satisfy the instructor staff 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, tuning fork
b. use of the otoscope in performing ear exams
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 during and after 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 identify signs of same
c. ability to use 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 recognize and manage simulated symptoms of toxicity

4. Essential Invasive Skills

- See Appendix 1

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 provision of emergency medical care in and outside the chamber; there is no primary intent to make the medic an expert on chamber operations

Since chambers in many areas are thinly staffed, perhaps by persons of limited 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. Secondarily, the medic is taught the rudiments of chamber operations, time-keeping, dive recording, pre- and post-dive checklists, and the conduct of a chamber treatment

A Sample Course Schedule is not given, as additional available time required will vary. Much of chamber operations training 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 remainder. As with Diving Medicine, much will probably depend on the individual instructor staff 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

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. CO_2 scrubber installation for chamber under pressure

6. **Operation of a CO_2 analyzer**