

SDSU DIVING ACCIDENT MANAGEMENT MANUAL

INTRODUCTION

The information contained in this manual is a simplified system of identifying and stabilizing diving accident victims and facilitating entry into the hyperbaric trauma care system. Divers may ignore the mild symptoms of bubble trouble in the early stages and by doing so they may eventually have more serious symptoms. Although primarily intended as a treatment guide for University diving operations in the field, it can also be used to insure that paramedics, physicians, Coast Guard and other assisting personnel understand and perform the specialized procedures for handling diving accident cases.

Portions of this first aid manual have been excerpted from:

- "Underwater Diving Accident Manual", Diving Alert Network, Duke University, Durham, NC, 1994.
- "NOAA Diving Manual", US Dept. of Commerce, US Government Printing Office, Wash, DC, 1991.
- Rutkowski, Dick, "Diving Accident Management," Florida Underwater Council, Miami, FL, 1982.

DIVER'S ALERT NETWORK

The Divers Alert Network was formed in 1981 to assist in the treatment of underwater diving accidents by providing a 24 hour telephone emergency call number: **(919) 684-9111**. This number can be called collect in diving emergencies. The call is received at Duke University Medical Center where it is connected with on-call physicians experienced in diving accident treatment. These physicians can deal with initial treatment of the accident and supervise referral to appropriate regional coordinators. If there is any doubt whatsoever regarding the expertise of an attending EMT, physician, hospital or transport agency in handling a diving accident victim, call DAN number without hesitation. Be prepared to give background information regarding the accident, name and telephone number or the physician/facility.

THE UNDERWATER DIVING ACCIDENT VICTIM

Arterial gas embolism (AGE) and **decompression sickness** (DCS), are the two most frequent serious scuba-related accidents. AGE, also known as air embolism, occurs when **air** bubbles entering the bloodstream through damaged lung tissue obstruct the blood flow to an area of the brain, heart, or spinal cord. Decompression sickness, also known as the "bends," is the syndrome of joint pains (the bends), paralysis, numbness, and other symptoms resulting from insufficient decompression or surfacing too rapidly from a dive resulting in the blockage of blood vessels by **nitrogen** bubbles. If not treated, both conditions can be fatal.

An underwater diving accident victim may be any person who has been breathing air underwater regardless of depth or time. Gas embolism can occur in as little as **four** (4) feet of water if one ascends holding his/her breath. Even a well-trained diver may encounter problems because of respiratory problems. Asthma, broncholithiasis, congenital or acquired cysts, emphysema, fibrosis, tuberculosis, infection and obstructive lung diseases may result in air-trapping in the alveoli during ascent. The expansion of trapped air may be sufficient to rupture air spaces and escaping air may cause emphysema of the lungs, mediastinum or neck. More serious problems of pneumothorax or arterial gas embolism may also result.

DCS:

Mild symptoms

Mild symptoms may respond to oxygen treatment at the scene. Fatigue (mild), skin rash, and weakness are considered a minor symptom, but frequently require recompression and are handled as a severe symptom.

If the diver surfaces from a dive and behaves in an unusual manner, appears confused, or has fatigue, weakness or skin rash, he may have early symptoms of a diving accident.

Immediately treat the diver for shock and administer oxygen. Oxygen treatment often relieves the symptoms or prevents them from getting worse. The victim will probably deny the possibility of having a problem and may refuse oxygen. Good judgment should prevail and the diver should receive treatment. If the symptoms appear relieved after an interval of oxygen treatment, do not remove the oxygen immediately as the symptoms may recur. The victim should continue to receive 100% oxygen for as long as the supply will last.

Severe symptoms

Severe symptoms consisting of joint pain, weakness or paralysis, staggering, respiratory difficulties or unconsciousness require immediate treatment and evacuation into the hyperbaric trauma system. Cardiopulmonary resuscitation (CPR) and/or the use of an Automated External Defibrillator (AED) will be required if the victim has no pulse or respiration. If a person at any time within 24 hours after a dive shows any severe symptoms, immediately provide the victim with oxygen and treat for shock. Monitor pulse and respiration until evacuation to the recompression chamber has been accomplished. It is important to remember that because these signs and symptoms can develop hours after diving, it is important for paramedics and physicians to recognize the symptoms and to understand this problem so that the proper procedure can be initiated. It is also extremely important that any person delivering a diving accident patient to a medical facility provide those caring for the patient with full information concerning the accident.

DECOMPRESSION ILLNESS/THE BENDS

Body tissues absorb gas in proportion to the surrounding pressure (depth) and as long as the diver remains at pressure (depth), the gas presents no problem. If the pressure is released too quickly (surfacing too rapidly or omitting required decompression), the inert gas comes out of solution and forms bubbles in the tissues and blood stream.

Decompression sickness (bends) is the result of inadequate decompression following a dive. While immediate recompression is not usually a matter of life or death as with an air embolus, the quicker recompression is initiated, the better the rate and extent of recovery.

CAUSES:

- Inadequate decompression caused by:
- Rapid ascent- exceeding 60 ft./minute
- Omitted decompression stop
- Ignoring pre-disposing factors, i.e., obesity, dehydration, cold-arduous dives,
 - flying too soon after diving, over-heating or overexertion after a dive.

SYMPTOMS:

- Joint pain
- Extreme fatigue
- Paralysis, numbness
- Unconsciousness
- Dizziness, staggering
- **Note:** Symptoms usually occur between 15 minutes and 6 hours after the dive, but can be delayed for up to 24 hours or more.

PREVENTION:

- Do not dive if dehydrated, hung-over, intoxicated, overly fatigued or cold
- Conservative use of dive tables, including safety stops, slow ascents, and longer surface intervals.
- If overweight be even more conservative in using tables
- Avoid exertion and over-heating after a dive, (hot showers/hot tubs, excessive anchor retrieval)

TREATMENT:

- Treat for shock: immobilize victim and protect from hypo/hypothermia
- Administer 100% oxygen
- Initiate Emergency Medical System (EMS)
- Administer fluids (water), to conscious, alert victim only.
- Perform neurological exam
- Evacuate to recompression chamber/hospital ASAP
- **DO NOT ATTEMPT IN-WATER TREATMENT**

ARTERIAL GAS EMBOLISM (AGE)

As a diver surfaces without exhaling, air trapped in the lungs expands and may rupture lung tissue releasing **air** bubbles into the circulatory system where they may be distributed to the body tissues. The ascending diver is normally in a vertical position and the bubbles tend to travel upward toward the brain, eventually reaching a small artery blocking circulation. The effects of halting circulation to the brain are critical and require immediate treatment. Symptoms of embolism may be present when the victim reaches the surface or within a few minutes afterwards.

CAUSES:

- Holding breath during ascent while breathing compressed air
- Lung disease causing air trapping
- Diving with cold, chest congestion
- Airway obstruction from foreign object in the mouth; gum, etc.

SYMPTOMS:

- Unconsciousness within 3-5 minutes of surfacing from a dive
- Dizziness, staggering
- Visual disturbances
- Paralysis
- Bloody froth from the mouth/nose
- Respiratory arrest
- **Note: Symptoms usually appear within 15 minutes after surfacing.**

PREVENTION:

- Always breathe normally during ascent
- Get a periodical medical examination by a hyperbaric physician
- Do not dive with cold or chest congestion
- Do not chew gum, tobacco, etc. while diving

TREATMENT:

- Treat for shock: immobilize victim and protect from hypo/hypothermia
- Administer 100% oxygen
- Initiate Emergency Medical System (EMS)

- Administer fluids (water), to conscious, alert victim only.
- Perform five-minute neurological exam
- Evacuate to recompression chamber/hospital ASAP
- **DO NOT ATTEMPT IN-WATER TREATMENT**

PNEUMOTHORAX

Air enters the chest cavity causing lung(s) to collapse.

MEDIASTINAL EMPHYSEMA

Air released into tissues surrounding the heart.

SUBCUTANEOUS EMPHYSEMA

Air trapped under skin around neck.

CAUSES:

- Holding breath during ascent while breathing compressed air
- Lung disease causing air trapping
- Diving with cold, chest congestion
- Airway obstruction from foreign object in the mouth; gum, etc.

SYMPTOMS:

- Shortness of breath
- Sharp pain in chest
- Rapid shallow breathing
- Blueness of skin, lips, fingernails
- Lungs sound different from one side to the other

PREVENTION:

- Always breathe normally during ascent
- Get a periodical medical examination by a hyperbaric physician
- Do not dive with cold or chest congestion
- Do not chew gum, tobacco, etc. while diving

TREATMENT:

- ABCs
- Administer 100% oxygen
- Treat for shock
- Do NOT use recompression without a chest tube. Physician will insert chest tube to withdraw air and re-inflate lung

CARBON DIOXIDE EXCESS

CAUSES:

- Over-exertion
- Skip breathing
- Hyperventilation; improper breathing pattern
- Loss of air supply

SYMPTOMS:

- Labored or rapid breathing
- Headache, dizziness, weakness, nausea
- Unconsciousness

PREVENTION:

- Stop, rest, breathe normally, surface if breathing becomes labored
- Avoid causes listed above

TREATMENT:

- Administer 100% oxygen
- ABCs, CPR, if required

CARBON MONOXIDE EXCESS

CAUSES:

- Inhalation of engine exhaust gasses

SYMPTOMS:

- Labored or rapid breathing
- Blue lips/fingernails
- Headache, dizziness, weakness, nausea
- Unconsciousness

PREVENTION:

- Do not breathe air contaminated with engine exhaust

TREATMENT:

- Administer 100% oxygen
- ABCs, CPR, if required

STINGING INJURIES

CAUSES:

- Stings from :Sponges, Corals, Jellyfish, Man-O-War, Fire Worm

SYMPTOMS:

- Itching, Burning
- Redness and swelling, welts, (such as with poison ivy)

PREVENTION:

- Avoid marine organisms with stinging potential
- Wear proper protective gear

TREATMENT:

- Check ABCs, Remove tentacles with saline rinse or remove carefully with forceps
- Use hot water, vinegar or diluted ammonia to deactivate remaining nematocysts.
- For severe injuries the victim should seek medical advice

NECESSARY INFORMATION

The who-what-where-and what do you need?

Be ready to provide the following information:

Name_____

Age_____

Sex_____

Location of victim (Boat, Ocean, Beach)

Vital Signs / Temperature

Pulse (Weak or Strong)

Breathing (Regular or Labored)

Treatment in Progress? (Oxygen / CPR)

Time of Onset of Symptoms:_____

Time of Treatment:_____

What are the symptoms?

- _____
- _____
- _____
- _____

PRIMARY SURVEY

1. Assess the accident scene
2. Assure an adequate airway (breaths <8 OR >24 intervene)
3. Assure adequate circulation (50> normal pulse <120)
4. Locate and control severe bleeding
5. Determine the level of consciousness
 - a. Alert and Oriented to
 1. Time
 2. Place
 3. Person
 4. Purpose
 - b. Verbal
 - c. Painful
 - d. Unresponsive
6. **Account for Dive Buddy** if one diver is hurt, very likely that dive buddy could also be soon showing signs of malady

SECONDARY SURVEY

1. Determine chief complaint
2. Record your findings if diving related
 - a. have you used compressed air
 - b. dive profile, past 24 hours
 - c. which table or computer (bring to chamber)
 - d. equipment problems (transfer to EMS)
 - e. what type of ascent (Rate/Safety Stop)
 - f. out of air?
 - g. dive weight issues?
3. Determine "AMPLE"
 - A**llergies
 - M**edications
 - P**ast illness
 - L**ast food or fluid intake
 - E**vents leading to this situation
4. Initially check and regularly assess vital signs
respiration, pulse rate, blood pressure and temperature, fluid intake

5 Minute Neurological Exam

Courtesy of Ed Thalmann, M.D., Assistant Medical Director of DAN

- 1. Orientation** - Does the diver know name and age? Location? What time, day, or year it is? Note: Even though a diver appears alert, the answers to these questions may reveal confusion, so do not omit them.
- 2. Eyes** - Have the diver count the number of fingers you display using two or three different numbers. Check each eye separately and then together. Have the diver identify a distant object. Tell the diver to hold head still, or you gently hold it still, while placing your other hand about 18" in front of the face. Ask the diver to follow your hand with his eyes. Move your hand up, down, side to side. The diver's eyes should smoothly follow your hand and should not jerk to one side and return. Check that pupils are equal in size. Note: Often AGE victims have different dilation in one eye then another. Also look for nystagmus (fluttering of the eyes either vertically or horizontally). This is a sign of neurological problems with the vertical fluttering being associated with more severe damage.
- 3. Face** - Ask the diver to whistle. Look carefully to see that both sides of the face have the same expression while whistling. Ask the diver to grit the teeth. Feel the jaw muscles to confirm that they are contracted equally. Instruct the diver to close the eyes while you lightly touch your fingertips across the forehead and face to be sure sensation is present and the same everywhere.
- 4. Hearing** - Can be evaluated by holding your hand about two feet from the diver's ear and rubbing your thumb and finger together. Check both ears, moving your hand closer until the diver hears it. Check several times and confirm with your own hearing. If the surroundings are noisy (i.e. a crowded beach), the test is difficult to evaluate. Ask bystanders to be quiet and turn off unneeded machinery.
- 5. Swallowing reflex** - Instruct the diver to swallow while you watch the Adam's apple to be sure that it moves up and down.
- 6. Tongue** - Instruct the diver to stick out the tongue. It should come out straight in the middle of the mouth without deviating to either side.
- 7. Muscle Strength** - Instruct the diver to shrug the shoulders while you bear down on them to observe for equal muscle strength. Check the diver's arms by bringing the elbows up level with the shoulders, hands level with the arms, and touching the chest. Instruct the diver to resist while you pull the arms away, push them back, up and down. The strength should be approximately equal in both arms in each direction. Check leg strength by having the diver lie flat and raise and lower the legs while you gently resist the movement.
- 8. Sensory Perception** - Check on both sides by touching as done on the face. Start at the top of the body and compare sides while moving downwards to cover the entire body. The diver's eyes should be closed during this procedure. The diver should confirm the sensation in each area before you move to another area.
- 9. Balance and Coordination** - Be prepared to protect the diver from injury when performing this test. Have the diver stand up with feet together, close eyes and stretch out arms. The diver should be able to maintain balance if the platform is stable. Your arms should be around, but not touching the diver. Be prepared to catch the diver who starts to fall. Note: If the diver is already messed up you may want to avoid this one if he can't even stand. Check coordination by having the diver move an index finger back and forth rapidly between the diver's nose and your finger held approximately 18" from the diver's face. Instruct the diver to slide the heel of one foot down the shin of the other leg. The diver should be lying down when attempting this test. Check these tests on both right and left sides and observe carefully for unusual clumsiness on either side.

Upon stabilization of victim(s), stow the dive gear (turn off tank, keep regulator dry, collect weights and dive computer) and provide for review by the EMS/Chamber Physician. Dive profiles can be downloaded from dive logs, air quality can be assessed from diver's tank.

EMERGENCY CONTACTS:

Mike Anghera, SDSU DSO: 805-698-1004

EMS Contact and Transport: 911

San Diego City Lifeguards: 619-221-8800 or VHF Channel 16

Sea World Marina: 619-226-3910

Sea World Security: 619-226-3800

USCG: 619-278-7032

Harbor Police: 619-686-6272

DAN-Diver's Alert Network

Diving Emergencies (Remember: Call local EMS first, then DAN!)

1-919-684-9111

Non-Emergency Medical Questions

1-800-446-2671 or 1-919-684-2948, Mon-Fri, 8:30am-5:00pm (ET)

All Other Inquiries

1-800-446-2671 or 1-919-684-2948

Hyperbaric Facilities:

UCSD Hillcrest Medical Center

200 Arbor Drive

San Diego, CA. 92103

Hospital Tel: **619-543-6222** (Emergency)

Chamber Tel: **619-543-5222** (Non-emergency)

24 Hr Phone: **619-543-6400**

Medical Director: Tom Neuman, MD

Sharp Grossmont Hospital

5555 Grossmont Center Drive

La Mesa, CA. 91942

Hospital Tel: **619-740-6000**

Chamber Tel: **619-740-4160**

Add. Emergency Medical Facilities:

UCSD Thornton Hospital

9300 Campus Point Drive

La Jolla, CA. 92037

Hospital Tel: **858-657-7000**

UCSD's Diving Medicine Clinic

Tel: **619-471-9210**



UCLA Gonda

200 Medical Plaza, Suite B265-29
Phone: **310-794-9014** 24 Hr Phone: **1800-UCLA888**
Medical Director: Susan Sprau, M.D.

Pacific Grove Hyperbaric Facility.

Pacific Grove
Phone: 831-**648-3110**

Newport Beach-Whitaker Wellness Inst. Medical Clinic

4301 Birch Street
Phone: **949 852-9855** 24 Hr Phone: **949 851-1550 x130**

Occupational Health Diving Clinic

330 Lewis Street, San Diego, CA. 92103.
Phone: **619-471-9210**
Medical Director: Karen Van Hoesen MD.

Santa Monica- HBO Clinic of Santa Monica

900 Wilshire Blvd, Suite 102
Phone: **310-260-0033**
Medical Director: William Stuppy, MD

Sherman Oaks- Sherman Oaks Hospital & Health Center

4929 Van Nuys Blvd.
Phone: **818 907-4586** 24 Hr Phone: **818 981-7111**

Thousand Oaks- Columbia Los Robles Hospital/Medical Center

215 W. Janss Rd.
Phone: **805 370-4557**

Catalina-Two Harbors-USC Catalina Hyperbaric Chamber

1 Big Fisherman's Cove
Office: **310-510-4020** Chamber: **310-510-4023** Emergency: **310-510-1053**
e-mail:chamber@usc.edu

Medical Director: Karl E. Huggins
<http://wrigley.usc.edu/hyperbaric/chamber>

San Diego Regional Poison Center

University of California at San Diego Medical Center
225 West Dickinson Street
San Diego, CA 92013-8925
(800) 876-4766 (CA only)
(619) 543-6000