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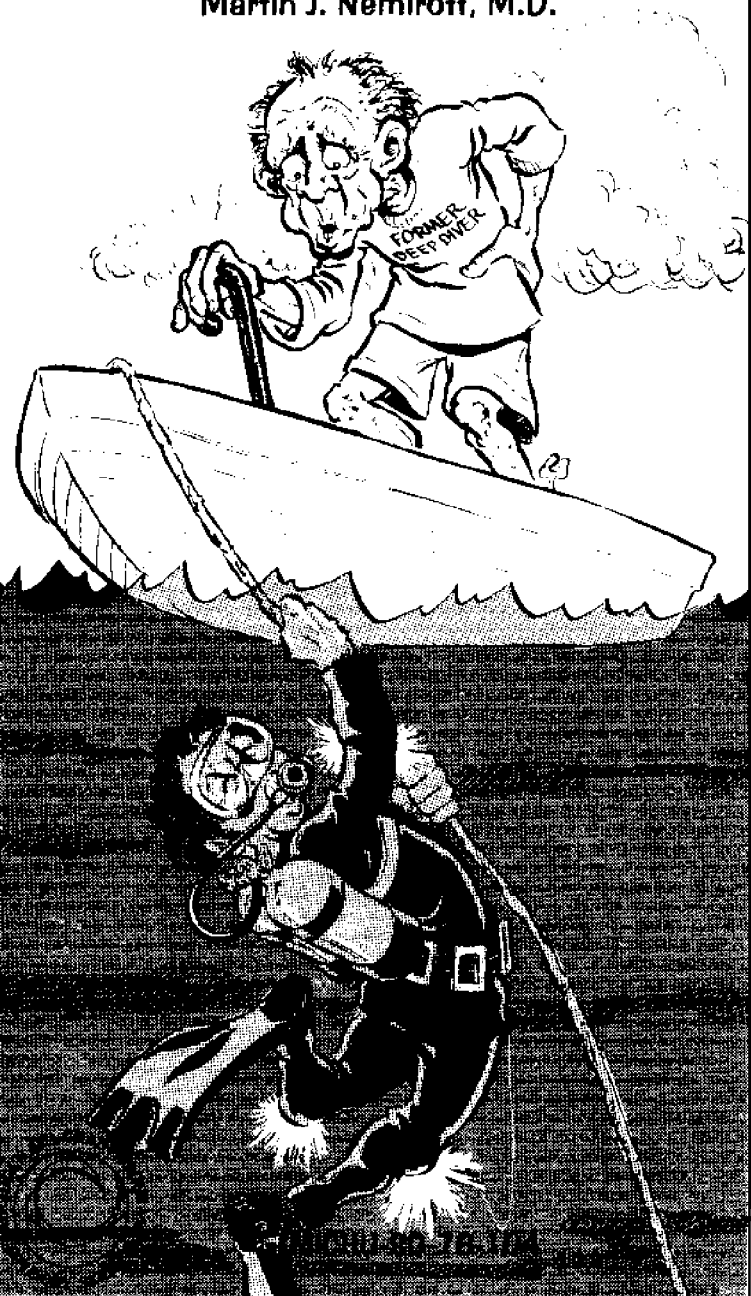
and the Sport Diver

by

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and

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Decompression sickness or the "bends" is occurring all too frequently in the sport diving population. This easily preventable diver's disease must be avoided. There is no need for sport divers to "take chances" and place themselves in situations that might result in "bends." Decompression sickness is serious. Its effects, especially if there is a long delay between appearance of symptoms and treatment, can be catastrophic and life threatening. Too often victims of decompression sickness are unaware of the proper procedures for using diving tables, sport diving limitations, the symptoms of and treatment for decompression sickness and the seriousness of the disease. Many scuba divers dive without the benefit of decompression tables, a watch (or dive timer) and depth gauge. These items of equipment are mandatory for safe diving.

The following are common questions asked by divers:

What are the recommended limits for sport divers? Most authorities concur that the absolute maximum depth limit for sport divers is 130 feet. Any dive beyond a depth of 60 feet is a deep dive. Sport divers should also remain *well within* the no-decompression time limits given by the U.S. Navy. These times are as follows:

Depth (in feet)	Time (in minutes)
35	310
40	200
50	100
60	60
70	50
80	40
90	30
100	25
110	20
120	15
130	10

Dives requiring decompression stops are considered as beyond the limitations of the equipment, training, and support facilities available to sport divers. All divers must know how to

accurately compute "no-decompression" repetitive dives.

Why are sport scuba divers requested not to exceed 130 feet? For any scuba diver, 130 feet is a deep dive. In fact, any depth in excess of 60 feet is "deep" for a sport diver. Limited air supply, short diver duration, potential decompression, nitrogen narcosis, loss of wet suit insulating efficiency, and increased difficulty in returning to the surface if air supply is depleted or malfunctions are among the many reasons for this limitation. From a practical viewpoint, there is simply very little to do on a deep dive and far less time in which to do it. Emergency situations that would be fairly easily resolved by routine procedures at shallow depths become extremely complicated and may cost the diver his life at greater depths. In any event, rapid emergency ascent from a deep dive most generally results in decompression sickness. Be conservative! Is there really that much more to do and see below 60 feet?

Why should I avoid "decompression" dives? Decompression implies required stops at given depths for specific time intervals during ascent. Depth and time measurements are critical. Failure to complete necessary decompression stops generally leads to decompression sickness. Furthermore, the incidence of decompression sickness is far higher in decompression diving than in no-decompression diving. From a practical viewpoint, if a diver errs in depth measurement, timing, or ascent rate, he is more likely to complete the "no-decompression" dive without injury than the decompression dive. A diver who conservatively plans his dive within the no-decompression limits is far more likely to survive an emergency ascent without developing decompression sickness.

Is the rate of ascent important? Yes! The U.S. Navy tables are developed with a prescribed 60 foot per minute rate of ascent. Deviations from this ascent rate require special procedures as given in the instructions for use of the tables. Failure to consider these special procedures can lead to decompression sickness. Sport divers are noted for violation of ascent rate standards. One study revealed that the average sport diver ascended at a rate in ex-

cess of 100 feet per minute. Some have been timed in excesss of 200 feet per minute in routine diving. Remember, it should take about 10 seconds to ascend from the bottom of an average swimming pool. Have you checked your rate of ascent? Use a watch and depth gauge; five feet in five seconds!

Can I get "bent" if I follow the U.S. Navy Standard Air Decompression Tables exactly?

Yes! Divers have suffered decompression sickness while following the tables exactly. There are a number of factors to consider. First, it is virtually impossible to develop a "practical," totally bends-free table to fit every individual and situation. The times and limitations would be prohibitive. Nitrogen absorption and elimination in the human body are dependent upon a number of variables. Tables have been developed to best protect a normal, healthy adult diver. Most statistical data in table use and testing is based on a medically and physically fit male population between the ages of 18 and 35 years. Physiological deviations associated with poor physical condition, aging, and obesity are sufficient to precipitate bends under the same diving conditions that would be safe for a normal, healthy young adult. Based on physiological differences, female divers are probably subject to a higher incidence of bends using standard tables than their male counterparts. There is very limited statistical data available on female scuba divers.

Second, the level of physical exertion and the thermal status of the diver alter nitrogen absorption-elimination. Persons who have worked hard and/or chilled significantly on a dive are more susceptible to decompression sickness. Third, daily diver condition is important. A higher incidence of decompression sickness can be expected in individuals who are suffering from minor illness (colds, diarrhea, etc.), lack of sleep, alcohol intoxication (and hangovers), alcohol or drug consumption prior to diving, and the like.

Finally, the tables are not perfect. Many divers state that a 5% incidence of decompression sickness can be expected using the standard U.S. Navy tables. Recent studies of the Navy diving population suggest that this figure is actually less than 1%. Some dive table

schedules show a greater tendency to produce trouble than others. For example, the "no-decompression" limit of 100 minutes for 50 feet is probably questionable. Recent studies suggest that 85 minutes might be more desirable. Divers using the exceptional exposure tables historically have a high incidence of bends.

Be conservative! Do not "push" the tables. Plan your dives to start your ascent before you reach the "no-decompression" limit. Avoid decompression dives!

How accurate is my depth gauge? The standard of accuracy for new depth gauges varies from $\pm 1\%$ to $\pm 5\%$ of full scale depending upon the gauge model and manufacturer. This means that a new gauge (250 ft. model) could have a variation range of 37.5 ft. to 62.5 ft. at an actual depth of 50 ft. and 117.5 ft. to 142.5 ft. at 130 ft. In addition, mechanical damage from use and abuse can cause even greater variation. Consult manufacturer's instruction sheet for accuracy information on new gauges and periodically check your gauge's accuracy against a precisely measured standard. Some divers use a tagged line or chain for this purpose. Do not assume that your gauge is accurate. An error of several feet could make a significant difference in establishing your "no-decompression" time limit. This error could result in decompression sickness. Another thing...are you sure you remembered to read the gauge at the deepest point of your dive? Be conservative! Check the accuracy of your gauge and, for a greater safety margin, add an extra 10 feet to the indicated depth when diving.

What about decompression meters? Decompression meters have been used with apparent success for years in sport diving. Studies comparing decompression meter readings with U.S. Navy tables reveal significant variations in "no-decompression" time limits for the same dive depth. Significant variations are also noted for decompression dives, repetitive dives, long surface intervals, and so on. These instruments are subject to mechanical damage from use and abuse. This damage may greatly affect the reliability of the instrument. Contrary to popular belief, divers *have* suffered decompres-

sion sickness while diving with decompression meters.

What about cold divers? A cold and/or fatigued diver is more susceptible to decompression sickness. The U.S. Navy requires that the diver use the next greater depth and/or time in computing the diver's decompression for cold and arduous dives. For sport divers, add 10 feet to the actual bottom depth for determining the "no-decompression" dive time limit. Under extremely cold conditions, also reduce the actual dive time to at least 10 minutes less than that allowed.

Do sport divers get bent frequently? Much too often. Many hyperbaric chamber facilities around the country report a higher incidence of decompression sickness among sport divers than commercial or military divers. An alarming number of probable bends go untreated each year. Numerous reports of sport divers experiencing joint pain, itching, dizziness, unusual headaches, muscular weakness, prickly skin sensations, and even temporary extremity paralysis or blindness circulate throughout the diving community. Many of these divers never apply for treatment. We estimate that untreated minor bends cases may occur in the Michigan area on any good summer weekend.

Should I make an "unrequired" decompression stop for added "safety?" This is a matter of personal preference and training. Many instructors encourage a three to ten minute stop at 10 feet during ascent from "no-decompression" dives. As long as the "safety stop" is not carried to an extreme by the diver we can see no harm in this procedure. In fact, considering all the variables involved, the stop may be quite beneficial.

How long must I wait until I fly after diving? Flying too soon after scuba diving can cause decompression sickness. NASA researchers recommend that divers allow at least a two-hour surface interval following only "no-decompression" dives in the previous 12 hour period. A 24 hour surface interval is required following a decompression dive. These figures are for routine commercial aircraft that maintain a cabin

altitude of 5,000 to 8,000 feet. Many small charter aircraft exceed this limit. Be conservative! Plan your dives to allow at least 12 hours before flying following a "no-decompression" dive.

What is aseptic bone necrosis and can I get it? Yes, you are subject to this disease! Aseptic bone necrosis is a disease process whereby normal bone is broken down and destroyed because of a lack of proper blood supply. All divers and pressure workers are subject to this disease because bubbles forming in the blood as a result of inadequate decompression may lodge in the nutrient arteries supplying the bone and block blood supply to the bone. Case studies reveal that aseptic bone necrosis can develop in individuals following only a single exposure to pressure without adequate decompression and from long dives to depths as shallow as 38 feet.

Currently there are little or no aseptic bone necrosis data available on sport divers. Long delays of months to years between pressure exposure and actual symptomatic development of the disease can be expected. Diagnosis of minor cases or early symptoms is difficult and requires special X-ray procedures and interpretations.

Advanced cases of this disease may be serious and crippling. Until more is known about the disease and its relation to sport divers, don't take chances. Be conservative!

How do I know if I'm bent? If you experience joint pain, extreme fatigue, severe dizziness, numbness and/or extreme weakness in your arms or legs, visual defects, and other "unusual symptoms" following a dive, you may be suffering from decompression sickness. You should immediately evaluate your diving schedule for the day and determine:

- Did I time my dives accurately?
- Were my depth measurements accurate?
- Did I stay within the "no-decompression" limits?
- Were my repetitive dives calculated accurately?
- Did I allow a "safety margin?"
- Did I avoid making decompression dives?

Did I injure myself during the dive?

Did I plan my dives and read the tables accurately?

If you have apparent symptoms of decompression sickness and you answer "No," or are unsure of the answer to one or more of the above questions, you may be "a victim." Symptoms generally appear within 2 or 3 hours following the dive. However, delayed symptoms *up to* 24 hours are possible.

What do I do if I suspect that I am a victim of decompression sickness? Remain calm, notify your diving buddies, and do not drive a car. Re-evaluate all aspects of your diving day. Be alert for intensifying pain, onset of extremity weakness or paralysis, etc. Maintain a qualified diver with you at all times; respiratory or cardiac arrest is possible. If symptoms persist and/or intensify, arrange for immediate transport to a hospital. Do not take drugs or pain killers! Take measures to prevent shock and breathe pure oxygen. Provide the examining physician with a complete history of the dive(s) and subsequent onset of symptoms. Physicians in the Michigan-Ohio area can contact the University of Michigan Medical Center Paging Service (313/764-4244, Diving Physician Motorola No. 146) or Emergency Room (313/764-5102) for consultation and recompression treatment information. Local physicians may also contact the U.S. Air Force School of Aerospace Medicine at Brooks Air Force Base, San Antonio, Texas for consultation and location of nearest hyperbaric treatment facilities. The emergency telephone number is (512) 536-3278 or simply dial area code 512 and the letters on the telephone dial that spell LEO FAST. Divers are cautioned not to use these numbers indiscriminately. Please reserve them for *physician* consultation and emergency services.

REMEMBER,

- Avoid decompression dives!
- Avoid deep dives!
- Know your depth and time accurately!
- Plan your dives!
- Dive your plan!
- Be conservative!



DRUGS

AND THE DIVER

Ours is an increasingly drug-centered society. We take drugs for everything from waking up to falling asleep. But drugs have no place in the diver's world.

What are drugs? You probably think of the more publicized "hard" drugs such as amphetamines and barbituates. But other drugs such as tobacco, alcohol, and aspirin can be as dangerous to the diver.

Drugs affect the body's biochemistry. They affect normal functions through distortion of sensations, perceptions, thought processes, and muscular control.

TYPES OF DRUGS

Downers: Downers include sedatives such as Doriden, Quaalude, barbituates, and opium and its narcotic derivatives (heroin, morphine, Demerol and Percodan). These drugs cause mental confusion or impairment. The fingers may become numb; breathing is slowed. Eventually these drugs cause sleep. This is the desired effect in a hospital setting, but it would be disastrous underwater.

Uppers: Uppers are powerful stimulants. They include the amphetamines. Initially, these drugs elevate mood, but they may cause subsequent depression. Uppers inhibit appetite, prevent sleep, and cause profound changes in behavior. Heavy users of stimulants show emotional instability, reduced mental functions and delusions of persecution.

Some divers mistakenly think amphetamines can counteract nitrogen narcosis. This is false! Amphetamines can actually increase narcosis.

Hallucinogens: Hallucinogenic drugs are the most dangerous of all for divers. They distort the real world, creating inaccurate perceptions. They may cause suppressed behavioral abnormalities to surface. Hallucinogens include LSD, psilocybin, mescaline, amphetamines, and others.

Current controversy centers over the question of the long-term effects of smoking *marijuana*. Besides the debilitating effects of smoke on the throat and lungs, this drug can produce adverse effects on the diver's mental processes, motor coordination, physical stamina, and cold tolerance. In warm weather, the diver may become ultra-relaxed, sleepy, unaware, and lazy. Work ability may be drastically reduced. It is unlikely that a "high" diver will be able to respond properly, if at all, in the face of panic or an emergency.

Smoking: Smoking any substance makes diving less safe. Smoke causes inflammation in the lining of the bronchi and increases the amount of mucus in the airways. This leads to airway obstruction and may result in lung barotrauma during ascent.

Heavy smokers can reduce their ability to use oxygen by as much as 15%. Carbon monoxide in the smoke combines with hemoglobin in blood cells, making it incapable of transporting oxygen through the body.

Aspirin: There has been a suggestion that aspirin may prevent decompression sickness. Presently, there is no evidence or any large-scale scientific study to support this. Therefore, aspirin is *not* recommended as a preventative.

Alcohol: Avoid alcoholic beverages before, during, or immediately after diving. Your safety is jeopardized by the effects of mental disorientation, lessened coordination, vertigo (dizziness), poor judgement, and general weakness.

Alcohol has other effects besides the obvious impairments. Drinking causes vasodilation of the skin, and increases the uptake of nitrogen by fat cells. Surface tension in the blood is reduced, favoring the formation and growth of gas bubbles. The amount of plasma fat increases, which favors blood clotting, an important factor in decompression sickness and aseptic bone necrosis. Alcohol also increases urine output, which can cause dehydration. This in turn, affects the circulatory system.

Alcohol in excess should be avoided in the 24 hour post dive period.

DRUG ABUSE

There has been little research in the area of drug abuse associated with diving. The high pressures encountered with depth may increase a drug's effects, reverse it's actions, or stimulate totally unrelated effects. For example, alcohol apparently increases nitrogen narcosis, whereas other sedatives may oppose it. Although research is understandably limited, it is known that many drugs do reduce oxygen tolerance. Some favor and others retard decompression sickness. Side effects are as yet unknown. Most drug interactions aren't clearly understood.

The safest measure a diver can take is to completely avoid drug abuse. Do not mix drugs, even prescription or "off the shelf" drugs. As a diver, you should always be in the best physical shape, with full and unhampered use of all faculties, ready to respond in any emergency. It is senseless to jeopardize the life of your diving partner because of ignorance of drugs and their related effects. Leave drugs at the surface, or you may leave the surface for good!

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This pamphlet, edited by Sandy Bacsanyi and Dr. Lee Somers, is one of a continuing series of safety and informational brochures. It was produced by the Michigan Sea Grant Program, a joint effort of the University of Michigan and the Michigan State University.

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Diving and Fitness



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Diving and Fitness

Physical fitness has finally become an American fad. Top physical shape, we know, will lead to improved circulation, an attractive physique, and good overall health. But good fitness is also a prerequisite for many physically demanding sports, especially scuba diving.

Good physical condition may be the most important aspect of diving safety. Flexibility, strength, and endurance are all necessary for underwater swimming and diving. The diver who is physically fit can stand greater amounts of exertion for longer periods of time, and can better handle physical and emotional stress in diving emergencies.

Diving can place severe stress on the entire body, especially the circulatory and respiratory systems. An increase in heart rate and fatigue can be caused by anxiety, lack of skill, overweight, cold water, and breathing resistance.

On the average, the recreational diver does not dive enough to maintain good physical condition. For the occasional weekend diver especially, diving must be supplemented by a regular exercise program. If you dive on a seasonal basis only, as most sport divers do, you should begin special conditioning six to eight weeks before the diving season, and exercise regularly when not diving.



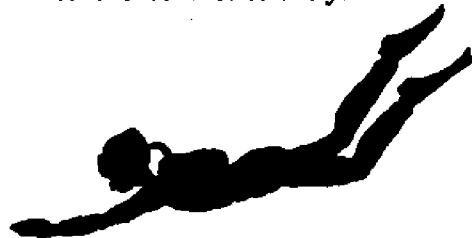
There are many different conditioning programs available to the public, in great demand at any local bookstore. Short of these cook-book fitness formulas or a doctor's recommended exercise program, jogging is probably the best single exercise for overall conditioning. Swimming, of course, is a must for every diver's fitness program. But any form of regular physical exercise will increase your physical fitness.

CONDITIONING PROGRAMS

The aerobics program, developed in 1970 by Dr. Kenneth Cooper, has proven to be one of the best overall conditioning programs. Aerobics is based upon exercises that stimulate heart and lung activity long enough to eventually produce adaptation by the body. This program includes such diverse exercises as running, walking, cycling, swimming, handball, basketball, and squash. What do these exercises have in common? They all force the body to work hard, demanding large quantities of oxygen.

The main objective of the aerobics program is to increase the amount of oxygen that your body can use in a certain amount of time. This requires the ability to:

1. breath large quantities of air rapidly,
2. deliver large volumes of blood quickly,
3. deliver oxygen from the blood to the cells efficiently.





Because the "aerobic capacity" reflects the general condition of the respiratory and circulatory systems, it is a good indicator of overall physical fitness.

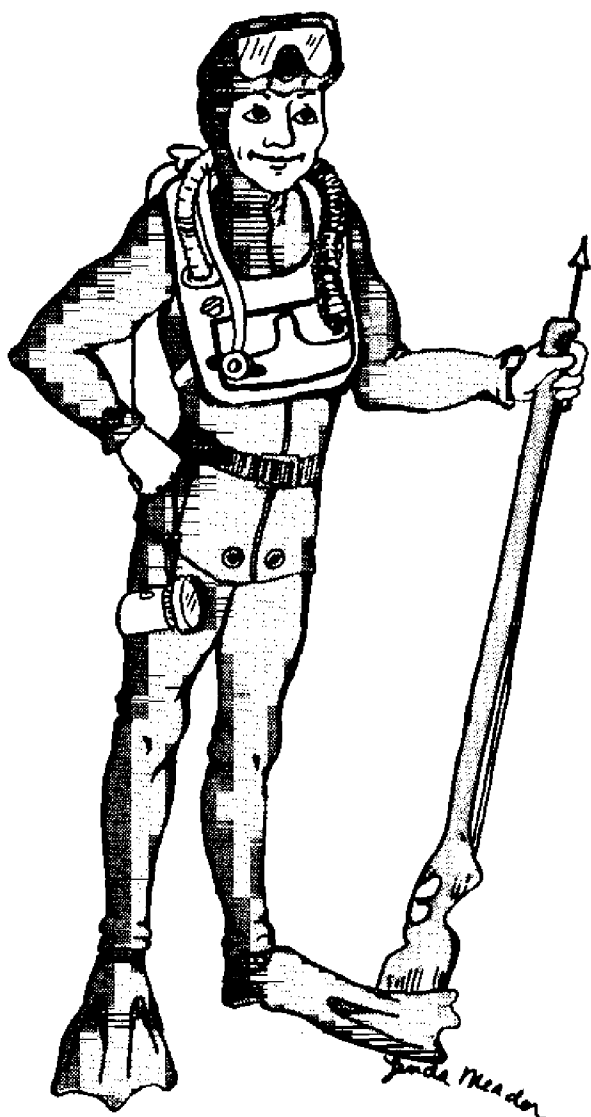
The "training effect" is the change produced in the body by regular exercise. Aerobic exercises produce this training effect by strengthening breathing muscles, improving the heart's strength and pumping efficiency, and toning body muscles.

If you are interested in starting an exercise program, or modifying an existing one, read Cooper's "The New Aerobics", or other publications recommended by your doctor or another fitness expert. Remember, everyone should have a good general medical examination before entering an exercise program. Consult your physician!



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The Deep Diving Syndrome



The Deep Diving Syndrome

LEE H. SOMERS, Ph.D.

How deep have you dived? Answer, "270 feet on a single 70." Wow, you must be a great scuba diver! Sound familiar? To many, this used to be the criteria for determining proficiency or status of a sport scuba diver. Fortunately through the efforts of knowledgeable diving instructors, *Skin Diver Magazine* and many individuals and organizations, the "deep sport diving record book" has been burned.

Unfortunately, there has been a recent re-emergence of the deep diving status symbol among sport divers. In the Great Lakes we frequently hear that "the only good wrecks are below 150 feet" and the "good" wreck divers are now going down to them on a routine basis. "Over-the-wall" appears to be the goal of every novice sport diver traveling to the Bahamas and Caribbean. Somewhere along the way, the sport diving community has created a new monster. I guess this deep diving monster has always been with us, but now he is growing at an uncontrollable rate.

At a recent YMCA instructor training workshop, I had an opportunity to review the applications of some candidates. The listing of scuba dives in excess of 180 feet is very common on these applications. However, of even greater concern is the increasing number of applicants who record dives in excess of 260 feet and one to a depth of 290 feet. Further investigations indicate that these dives are being accomplished on standard compressed air scuba, generally a single 70. Are these listings "valid" or simply attempts to impress the staff? I personally feel that these depth figures are valid within the normal error of depth gauges. Sport divers are going deep every day.

I recently interviewed a young lady with 7 years diving experience who had made a 275 foot over-the-wall dive in the Caribbean in January 1974. The total dive time was approximately 20 minutes on a single 70 with little or no stage decompression. Upon returning to the boat she didn't feel well and experienced severe fatigue. She rested or slept for about four hours and awoke with some pain in her left shoulder. She didn't feel well and experienced some degree of shoulder pain through the night. Early the next morning, approximately 18 hours after completing the dive she boarded an airplane for the return trip to the States. The shoulder pain intensified soon after gaining altitude and a decision to seek professional help for treatment of decompression sickness was made upon arrival in New Orleans. The young lady underwent recompression treatment for approximately 3 hours on oxygen tables. Unfortunately, shoulder pain recurred shortly after treatment, however, the victim didn't return to the chamber for further treatment. One month later she is still experiencing intermittent shoulder pain, weakness in her left arm, and problems moving her arm. Fortunately her buddy returned to a depth of 10 or 20 feet for 20 or 30 minutes and decompressed. Apparently he did not suffer symptoms.

My Labor Day weekend last year was spent at the University's Underwater Technology Laboratory treating a sport diver stricken with a serious case of decompression sickness. When the diver arrived at the chamber, he was paralyzed from the fifth thoracic vertebra down. He had made two 150 foot dives earlier that day. His automatic decompression computing instrument apparently indicated he was clear to surface without decompression stops on both dives. After 43 hours of treatment, three weeks of hospitalization and physical therapy, and a period of convalescence, this diver was able to return to a relatively normal life. He was fortunate.

In my contacts with divers, diving instructors, and diving students I have noted the following significant factors:

1. The hazards of diving are being de-emphasized in many diving courses. Novice divers have only a limited knowledge of the real and more serious consequences of inadequate decompression. Few have been informed about such problems as aseptic bone necrosis.

2. Some diving instructors still emphasize sport diver automatic decompression computing instruments as substitutes for accepted U.S. Navy Standard Air Decompression and Repetitive Dive Tables.

3. Dives to depths exceeding 200 feet are commonly made on a single 70 scuba.

4. Many sport divers have only limited knowledge of nitrogen narcosis or respect for the serious physical and mental impairment that may be induced by nitrogen narcosis.

5. Consciously or unconsciously many diving instructors are perpetuating the deep diving syndrome by publicizing their personal exploits. The instructor who uses his recent experience of a 290 foot dive off Cozumel as an example in a basic course is accomplishing little more than providing his students with a depth to shoot for. Do you, the diving instructor, brag just a little bit about your deep dives?

6. Is 130 feet a realistic figure for "the sport diver depth limit?" Many of us emphasize this in our classes. Or does this just set another goal to be reached and exceeded like the 50 mph speed limit? Would it be better if you presented your course so skillfully that, on the final examination, each student arrived at a reasonable and prudent depth figure on his own? The magic 130 foot figure is common knowledge to most novice divers, but few truly understand why a depth limitation is established.

7. The increasing popularity and availability of variable-volume dry suits is allowing divers to dive deeper and longer with far greater comfort than previously in wet suits. Air consumption is reduced and the diver is comfortably warm for repetitive deep dives.

Divers who were previously forced to the surface by cold and high air consumption are now doubling their underwater time.

8. Deep dives are generally poorly planned. In many cases exceptional exposure tables (for dives exceeding 190 feet) are not even available at the site. Decompression, if any, is haphazard.

9. Very few novice or experienced divers know the U.S. Navy emergency procedure for handling an omitted or interrupted decompression. Do you?

10. Many divers and instructors are unaware of the special decompression procedure for a cold or arduous dive. Are you?

11. In this paper I do not intend to place the blame on instructors, novice divers, equipment manufacturers, or organizations. It is not my place to act as judge and jury. Rather, I'm calling on the diving community to reassess its "values" and for each individual to examine his or her own conscience relative to the deep diving syndrome. Frankly, I'm scared! I'm one of the guys that has to turn the valves on the chamber.



This article has been reprinted from NAUI NEWS, April 1974 by permission from the National Association of Underwater Instructors.

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Drawing by Sam Viviano.

Cold-Water and Under-Ice Diving



Cold-Water and Under-Ice Diving

Each year thousands of people discover the fascinating sport of SCUBA diving. While the total number of sport divers has increased enormously in the last decade, the percentage of cold-water (less than 50° F water temperature) and under-ice divers has increased much more. You may be among the 25% of all civilian divers that dive in waters below 40° F. Many take advantage of Michigan's Great Lakes, where water temperatures are usually cold. In general, cold-water diving does involve a higher element of risk than warm-water diving.

The high potential risk associated with cold-water and under-ice diving could be greatly reduced by caution and common sense. Most accidents happen with a less than 50% ice cover on a lake or pond. Divers, imagining safety, swim from open water to ice cover and lose their way. This could easily be prevented by use of a safety line, or by towing a large surface float.

Many divers don't realize the high risk involved in cold-water and under-ice diving. Cold-water diving is barely comparable to its warm-water counterpart. Cold water strains the capacities of both diver and equipment; thus specialized training and equipment are helpful.

If you intend to participate in under-ice diving, your best bet is to enroll in special courses in ice diving offered by YMCAs, public education programs, and private diving schools.

What is cold stress? Cold stress is simply the limiting factor of cold on your diving performance, comfort, and safety. Upon contact with cold water, surface layers of your body are immediately cooled, your blood vessels contract, your metabolic and respiratory rates go up, and your heart rate goes down. Your body tenses into a defensive state against the cold. Continued exposure to cold leads to localized cooling of the extremities. Muscle strength in the hands and feet often decreases to a level of uselessness; your hands will be too numb to perform manual skills. Studies have shown that as little as one minute of exposure in 50° F water leads to a 50% decrease in grip strength.

Prolonged exposure leads to a decrease in skill level, motivation, and anticipation. Clearly, cold divers are hazards to themselves and others.

If you can sense that you are suffering cold stress, you will probably protect yourself against the more severe effects of hypothermia. Hypothermia involves a lowering of the body's core temperature. Whether you are diving or standing by on the surface, you should be able to recognize symptoms in yourself and others. Intense shivering, fatigue, slowing of physical movements, poor articulation, feelings of deep cold and numbness, and blueish skin are just some of the symptoms. If they appear, take measures quickly to reduce heat loss and provide supplementary heat.

Could I get frostbite or snowblindness? Yes. Exposed skin surfaces are susceptible to frostbite, which can occur when skin temperature drops below 50° F.

Divers and surface tenders must also be wary of snowblindness caused by over-exposure to bright and reflected light, common conditions on a frozen lake. Normal driving sunglasses do not provide sufficient protection. Snowblindness symptoms often don't occur until hours after exposure. They include a feeling of grit in the eyes, pain, watering, and redness, often accompanied by headaches.

Should I get special equipment for cold-water diving? Yes and No. Most of the equipment used in regular SCUBA diving can be used in cold-weather diving. This includes mask, fins, weight belt, knife, complete exposure suit, a 71.2 cubic foot SCUBA with submersible pressure gauge, a watch and a depth gauge. Extra equipment needed are safety lines and a body harness. A snorkel may be useful in some emergencies, but should be carried on the body with other equipment, to prevent catching on the safety line. Double hose regulators although scarce, are still recommended by some authorities because the more popular single hose regulators can be a problem in cold-water diving.

In one study of regulator function in cold weather, 48% of the single-hose regulators tested malfunctioned in the open position due to internal freezing. Less than 4% of the double hose regulators malfunctioned. Thus, the diver must be alert to regulator malfunction and be prepared to return immediately to the surface. Also, to prevent moisture buildup and freezing of the regulator, the air in the tank must be absolutely moisture-free. Other precautions are: (a) avoid getting water into the regulator when rinsing, (b) avoid precooling the regulator before the dive, (c) use a dual regulator-cylinder system with a crossover unit for emergency air, and (d) avoid pressing the purge button for over five seconds.

Recommended safety lines are made from polyethylene or polypropylene. They float and stay out of the way. Manila may be used, but it breaks easily after freezing. The safety line should be tied to a stake at the surface or to the ice shelter.

How should the long-suffering surface crew look after themselves? The surface crew should wear wool and down garments to keep warm, and they should use a shelter in bad weather. The crew should strive to keep warm and dry. The insulating qualities of down-filled garments degenerate rapidly when down becomes wet. Remember, it is usually the surface crew members who are most affected by the cold. The diver's environment has a relatively constant temperature. The crew is faced with problems of cold, windchill, wetness and inactivity.

What emergency first aid should I know for cold water diving? Should the symptoms of frostbite appear, place the frostbitten area next to an exposed body part, or immerse it in water warmed to body temperature (90-100° F; 32.2-40° C). Do not rub. Rubbing can further damage the tender capillaries and skin cells. Give non-alcoholic liquids to victims. They should not smoke because it constricts the blood vessels of the extremities. Leave blisters alone to avoid infection. Exercise helps in restoring circulation, but again, do not rub. When possible, consult a physician.

Symptoms of snowblindness do not appear until after exposure. The effects of snowblindness usually disappear within a few days, but some measures can be taken to relieve discomfort. Cold compresses help, and eye bandages help prevent further irritation. Again, do not rub. It only aggravates the problem. Finally, consult a physician.

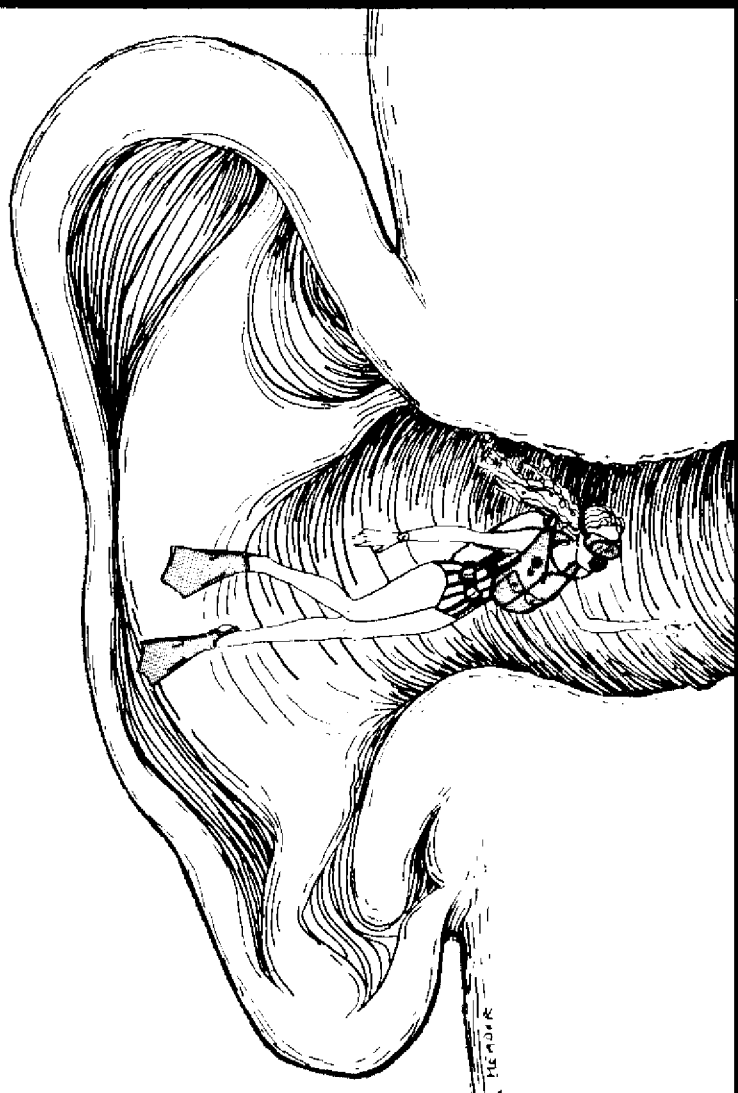


This brochure was condensed from "Cold Weather and Under Ice Scuba Diving" by Dr. Lee H. Somers, Program Leader of the Michigan Sea Grant Program's Underwater Technology Project. The brochure was written by Sandy Taesaoyi and Craig Tomkow, students in the University of Michigan's School of Natural Resources. It was produced by the Michigan Sea Grant Program, a joint effort of the University of Michigan and the Michigan State University.

"Cold Weather and Under-ice Scuba Diving" 39 pages, can be ordered from: NAUI Headquarters, P.O. Box 630, 22800 Barton Road, Grand Terrace (Colton) California 92324. Price: \$3.95.

Drawings by Sam Viviano, Romona Bolton

The Diver's Ear

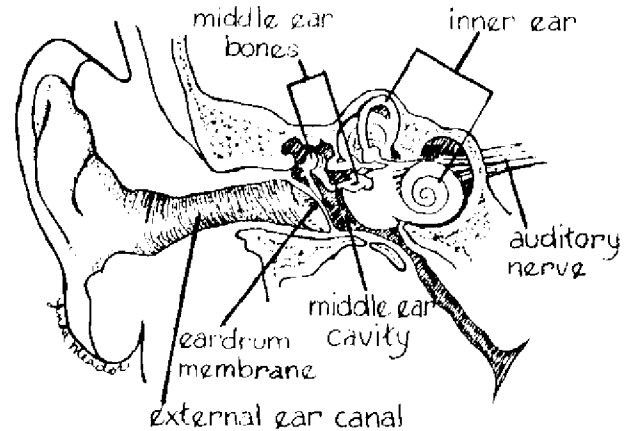


THE DIVER'S EAR

What sensation do you first feel when you dive into any body of water? Chances are, you will instantly note water temperature, and then, the feeling of pressure on your ears. This ear pressure is normally accompanied by the sounds of popping as the pressures try to equalize between ear cavities and the external water atmosphere. Pressure equalization must occur at all depths, beginning as soon as you submerge. Failure to equalize pressure can be very painful and develop into a serious injury.

The ear and sinus cavities are open-air spaces in the body. Therefore, they are the most susceptible to barotrauma, or pressure injury. The cavities are lined with membrane which contains blood vessels. During a dive, the external pressure on the body changes. These pressure changes are transmitted to the cavities via the fluid portion of the body. Pressure must be equalized or ear injury will occur.

The most common ear problem in diving is middle ear injury. The eustachian tube (see drawing) is the only communication for pressure between the middle ear and the external atmosphere. Even under normal conditions, the eustachian tube may restrict the flow of air into the middle ear. It may also be blocked by inflammation, allergies, irritation from smoking, overuse of nosedrops, mucus or congestion, tissue overgrowth, and swelling. Any or all of these will prevent pressure equalization and cause painful middle ear squeeze. Continued descent without equalization may cause the eardrum to rupture. All divers should know middle ear pressure equalization maneuvers.



Pressure abnormality is easy to detect. You will experience pain or an uncomfortable feeling during the first few feet of descent. Further descent without equalizing ear pressure will result in more pain. The eardrum will stretch; blood vessels may break. Eventually, the eardrum ruptures. It can happen in as little as 10 feet of sea water.

EQUALIZING PRESSURE

There are many simple methods to equalize ear pressure, including swallowing and yawning. One of the most common techniques is the "Valsalva Maneuver". Part of this maneuver is a forceful exhalation against your closed nose. Performing the Valsalva Maneuver too vigorously can cause inner ear injury and even hearing loss. You are advised to use the Valsalva Maneuver with caution. Avoid excessive forceful applications especially in cases where only one ear equalizes.

These simple maneuvers become complicated if you "let the pressure get ahead of you". Don't wait for pain as the signal to start clearing your ears. Rather, start equalization immediately when you begin your descent, or at least when the first sense of pressure change on your ear is felt. Pain is the indicator of barotrauma, not the warning signal.

For many divers, body position has an influence on pressure equalization. In a head-first descent, blood vessels in the head dilate to accommodate the increased blood supply. This causes swelling in the walls of the eustachian tube, restricting air flow into the middle ear. Descending feet first alleviates this problem.

Some divers experience vertigo (dizziness) during descent. If you do, stop and ascend far enough to clear your ears, even if this means returning to the surface. If you notice symptoms during ascent, stop and descend until they disappear (as long as air supply and conditions permit). Attempt to equalize pressure by yawning and swallowing.

Vertigo can also result from the cold water entering the external ear canal. In this case, unlike barotrauma, the symptoms should subside within a minute as the water warms.

REVERSE EAR OR SINUS SQUEEZE

During ascent, the ears and sinuses generally vent the expanding gas without too much difficulty. Sometimes, though, swelling of tissue injured during descent may result in reverse ear or sinus squeeze. To relieve this pressure, descend slowly until equalization occurs; then ascend slowly.

EXTERNAL EAR SQUEEZE

Ear plugs and watertight diving suits present additional diving hazards. External ear squeeze can occur unless air is somehow allowed into the ear canal during descent. External ear squeeze is basically the same as middle ear squeeze, with equally painful consequences. Ear plugs are hazardous not only because they prevent pressure equalization, but they may also be driven deeper into the ear by increased water pressure.

Thin, tight-fitting hoods or dry suit hoods should be used with caution. The more common foamed-neoprene wet-type suit usually eliminates these problems.

The possibility of ear problems is increased by ear infection. Infection risk is highest in cases of excessive exposure to humid or water atmospheres, and when the water bacteria content is high. Especially in the tropics, divers are susceptible to many forms of fungus, some of which can cause deafness if not treated. Infection can also be induced by pushing fingers or other objects into the ear.

If you have any of the ear infection symptoms, such as continued irritation or itching, burning, discharge, acute inflammation, tissue swelling, or pain, seek medical advice. A physician may recommend cleaning the ear canal, use of antibiotics, and routine use of ear solutions following dives as a preventative measure.

The best treatment, of course, is prevention. Keep your ears as clean and dry as possible, perhaps with the aid of a hair dryer or a special drying solution available at the drug store.

DECONGESTANTS

Long-acting decongestants help to relieve ear and sinus congestion. Decongestants, whether oral or local, tend to keep the nasal passages, sinuses, and eustachian tubes clear by shrinking the surrounding membranes. Ask your physician or diving instructor to recommend an appropriate decongestant, and to instruct you in its use. Don't randomly sample non-prescription drugs from dive shops, drug stores, or friends. Do not use a decongestant for diving when you have a cold. Try out the decongestant at least 24 hours before diving. This way you can avoid any adverse effects like an allergic reaction.

Beware of the "rebound phenomenon" when the effect of the decongestant wears off. This can lead to even greater congestion with increased pressure equalization problems during the dive. Equalization upon ascent may be difficult. Overuse of nasal sprays may even cause congestion.

EARDRUM RUPTURE

Eardrum rupture is usually accompanied by a sudden relief in pain. If cold water enters the middle ear cavity, the sense of balance may be violently upset. The diver may experience vertigo and may vomit. These reactions subside as the water warms to body temperature, usually in a few seconds to a minute.

A ruptured eardrum heals quickly; normally in a few days. But if the middle ear becomes infected, or if water enters the ear canal during the healing period, recovery may take much longer. Always consult a physician if you suspect your eardrum is ruptured.

Ear pressure equalization can be a severe problem for some divers. It may be best to experiment in a pool to determine how your ears function under pressure. Remember that although you may have had no pressurization problems in the past, changes in age, physical condition, illness, and a variety of other factors can cause new equalization problems.

Open each diving season with a shallow practice dive to note any new pressurization problems. Discover which ear-clearing method works best for you, and practice it until clearing your ears becomes an easy, pain-free habit. Avoid the disappointment of ending your dive at five feet, while the rest of your party swims comfortably to the depths.

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