

DIVERS alert 919-684-8111

(Singapore Guy - Get Best of 7-Continent)

V = R3

Catalina Marine Science Center

ANDY Pilman

Proposed Course Outline

Diving Accident Management for Emergency Physicians

Friday, September 20, 1985

9:30 pm - Arrive at the Isthmus on Catalina Express. We will pick-up with vans and transport to CMSC. Check into rooms.

Saturday, September 21

7:30 am - Continental breakfast

8:00 am - Lecture:

1. Introduction to Hyperbarics
2. Movie "Depth Trap"
3. Review of Diving Physics
4. Effects of Pressure Change

11:00 am - Brunch

12:00 pm - Lecture

1. Decompression Sickness
2. Air Embolism
3. Movie "Pathophysiology of Spinal Cord Decompression Sickness"
4. Hyperbaric Chambers and Chamber Operations
5. Field Management of Diving Accidents
6. Hyperbaric Treatment Procedures for Diving accidents
7. Hyperbaric Treatment of Carbon Monoxide Poisoning

5:00 pm - Dinner

Sunday, September 22

7:30 am - Continental Breakfast

8:00 am - Chamber Briefing  
165 fsw Chamber Dives (2)

10:30 am - Lecture:

1. Causes of Diving Accidents
2. Case Histories

11:30 am - Brunch

12:30 pm - Transport to Isthmus by van

2:00 pm - Depart on Catalina Express

USC Medical  
Dir Phil  
213 521-4114

Catalina  
Em  
213 510-1053

- 1. Bubble Reduction
- 2. 60 FT or less 100<sup>02</sup> mask tests critical
- 3. Bubble Resolution
- 4. Hydration
- 5.

COXIGMATION  
OF HYPOXIC  
TISSUES  
20MIN 02/5AIR/20<sup>M10</sup> 02.

getting rid of Bubbles  
(100% N<sub>2</sub> bubbles)

diving causes dehydration

JL -  
Thank for it's!  
ment in his  
late out  
(B. Blackwell)

Chest X RAY -  
lung problems  
clut clut -

Dealing with "Edema" (Swelling of Tissue)  
(Hyperbaric oxygen decreases Edema)

Treatment #108  
February 19, 1978

A 24-year-old male commercial urchin diver was diving with hookah at Santa Cruz Island. His first dive was to 45-50 feet for a total of two hours, although he made numerous ascents to the surface just long enough to exchange collecting bags. On the surface after this dive, he felt nauseous and vomited. A five-minute decompression stop was required for this dive but was ignored. After a 10-15 minute surface interval, he made a second dive to 20-30 feet for two hours, and the nausea disappeared. He felt fine immediately following the second dive, but two hours later he developed a headache along with chest, neck and shoulder pains. The chest pains increased and six hours post dive the patient presented to a mainland hospital. He was referred to the hyperbaric physicians at LAC-USC Medical Center and arrived at the Catalina Chamber 10 hours post dive. A physical examination revealed chest tightness, headache, deep nonspecific discomfort of the shoulders and left elbow, neck pain, and mild confusion.

He was treated on a Table 6 with an initial bounce to 165 feet. At 165 feet the headache disappeared, and there was a reduction of the neck, shoulder and chest pains. During the first O<sub>2</sub> period at 60 feet, the neck and shoulder pain disappeared and the chest tightness improved to a mild heaviness. During the remainder of the treatment, there was a substantial reduction in the chest pain although it was not eliminated. He was held for six hours post dive at the chamber then transferred to the LAC-USC Medical Center.

TREATMENT #104

1/22/78

A 22-year-old male sport diver made a single dive to 50-55 feet for 30 minutes off Zuma Beach. His ascent was apparently normal. Within a few minutes of surfacing, he lost the use of his right leg. He first noted numbness and pins and needles of the right foot followed by flaccid paralysis of the right leg. Symptoms began to resolve during transport to the chamber (he was being given 100% O<sub>2</sub> and was in the Trendelenberg position). At the chamber he showed partial paralysis of right leg and numbness and tingling in right toes. He was immediately treated on a Table 6A. At 165 feet a mixture of 47% O<sub>2</sub> - 53% N<sub>2</sub> was given by mask. Upon reaching 165 feet full strength had returned to the right leg. Numbness in the toes had decreased but was still there. After 15 minutes at 165 feet he was asymptomatic except for slight numbness and discoloration of 4th toe. This condition persisted until reaching 30 feet. He was asymptomatic at surfacing and was diagnosed as having had an air embolism.

TREATMENTS #103, 105, 106, 107

1/19 - 1/26/78

A 32-year-old male commercial diver made 11 dives to 55 feet between 1040 and 1515 (1/18) off Huntington Beach using scuba. The estimated combined total bottom time of all dives was between 120 and 150 minutes. The surface intervals were unknown and no decompression was done. At 1830 he developed tingling in both legs with numbness from the hips down. He did not seek help until the next day. When examined at the chamber at 1410 on the next day (1/19) he was found to have a dull ache in the left shoulder, a limp favoring the right side, weakness of the right leg and arm, numbness of right leg, right arm and shoulder and right face. He also consistently missed his nose (low) with right finger when standing with eyes closed. He was diagnosed as neurological decompression sickness (treatment delayed almost 24 hours) and given a Table 6 with an initial bounce to 165 feet. Patient was examined during the second O<sub>2</sub> period at 60 feet and found to be asymptomatic. He was taken to the hospital after the treatment and released after an observation period on 1/20. At the time of release, the examination found him normal in all areas. However, the patient later reported that at that time he had felt a 'heaviness' and tingling of his legs, but did not report it. Over the next 12 hours after his release, these sensations worsened. The following day (1/21) at 1230 he returned to work and made two dives to 55 feet for 6 minutes each. He reported that at depth his symptoms resolved, but within 30 minutes after surfacing they returned with gradual worsening over the next day and a half. These consisted of weakness in both legs, the right worse than the left, and tingling sensations. On 1/23 in the A. M. he made another dive to 55 feet. The bottom time was 25 minutes. Again, he reported relief of symptoms at depth and a return within 30 minutes after surfacing. Again, there was a progressive worsening with time. He was brought to the chamber at 2100 (1/23) 5 days after the initial insult. On examination, he was found to have slight motor deficit in the right arm and leg with a sensory deficit in the right outer knee, calf, ankle and toes. He had a noticeable right-sided limp. He reported bilateral leg parasthesias. He was treated on a Table 6. Within 3 minutes at 60 feet he reported that the parasthesias were gone. By the 2nd 20-minute O<sub>2</sub> period at 30 feet the patient was found to be asymptomatic. After the treatment, he was returned to the hospital (1/24) and after some hours examined by a neurologist. Again, a definite neurological deficit was found by the neurologist and the patient was returned to the chamber. He was again found to have left shoulder pain and both motor and sensory deficit, on the right face, arm and shoulder and the lower leg. He was treated on a Table 6. The left shoulder pain resolved after 5 minutes at 60 feet. By the end of the treatment all the sensory deficit had resolved, however, slight motor deficit remained in the right leg. He was again returned to the hospital. He was again returned to the chamber the next morning (1/26) with weakness of the right leg and parasthesias of the right leg and arm. He was treated on a Table 5 and came out asymptomatic.

Treatment #111 & 112

8 July 1978

A 19 year old male was diving off Laguna Beach with other students and a dive instructor on their first ocean checkout dive. At the conclusion of the dive, each student in turn, performed an unassisted free ascent from 30 feet with the regulator out of the hand and mouth while the instructor watched from the bottom. The patient's father, also a student, reported that the patient appeared to ascend slower than normal. The patient stated he felt he had "let it all out by 10 feet" and continued to the surface "holding his breath". At the surface, the patient yelled "Dad, I'm blacking out! I'm blacking out!" When his father reached him, he was incoherent, disoriented, and had no strength on his entire right side. There was no documented loss of consciousness. On the beach, one lifeguard felt the patient had suffered a "stroke", while the dive instructor felt it was hyperventilation". The patient was placed in a head up position for about five minutes. He vomited blood-tinged fluid and still had right side weakness and decreased sensation. During transport to the hospital, he was placed on O<sub>2</sub> and in trendelenberg position.

At the hospital, the patient complained of weakness and parasthesia on the right side and lower extremities. A physical exam revealed weakness in the right shoulder (later clearing at the hospital), equivocal Babinski on the right, intermittent "crackles" at the left lung base, and subjective weakness in the right hand and arm.

The patient was then transferred to LAC-USC Medical Center and arrived at the CMSC Hyperbaric Chamber six hours post-dive. A physical exam at this time revealed full strength in all extremities, clear lungs, normal rectal tone and spasticity of the right arm and hand, making it difficult to shake hands, write, and point to nose. He also complained of nausea, left lower posterior chest pain, and tingling and numbness in the right arm and leg. The patient was recompressed to 165 feet on a Table 6A, using a 47/53% N<sub>2</sub>O<sub>2</sub> breathing mixture. After 10 minutes at 165 feet, the spasticity was eliminated, but the patient continued to have difficulty in directing right arm motion. After 23 minutes at 165 feet, the chest pain was eliminated. Ascent to 50 feet was uneventful (time at 165 - 27 minutes) and during the first O<sub>2</sub> period at 60 feet, the patient reported less tingling in the lower right arm. During the first air break at 60 feet, there was a progressive deterioration in coordination of the right arm, with great difficulty in writing and finger-to-nose coordination. Sensory exam and rectal tone were normal. Lower back pain began to develop, although the patient reported a ruptured disk requiring outpatient traction treatments four years ago. During the fifth O<sub>2</sub> period at 60 feet, the patient had a definite decrease in sensation to pinprick below the right hip and involving the entire right lower extremity. Strength in arms and legs was normal, with tingling in right arm increased, and numbness decreased. After a conference call and discussion, it was decided to ascend to 30 feet, and to consider a modified Table 4 if symptoms and signs worsened. During ascent, there was a dramatic improvement in finger-to-nose coordination and his handwriting was described as normal by his father. During the following 12 O<sub>2</sub> periods at 30 feet, the

patient experienced varying degrees and periods of tingling in his right arm, especially below the elbow. Sensation was restored to the right lower extremity. He also vomited and reported a recurrence of the lower back pain. At the conclusion of the treatment (27 minutes @ 165 feet, 5-O<sub>2</sub> @ 60 feet, 12-O<sub>2</sub> @ 30 feet) there was continued tingling sensation in the right forearm (glove pattern), persistent point tenderness over the posterior iliac crest, and good coordination. He was held overnight at the CMSC Chamber and retreated six hours later on a modified Table 5 (3-O<sub>2</sub> @ 60 feet, 1-O<sub>2</sub> @ 30 feet).

The exam prior to retreatment showed no change from post-treatment exam (6 hours earlier). During the first O<sub>2</sub> period of the retreatment, the patient reported that his right arm felt clumsy, however, exam showed smooth finger-to-nose movement and writing was also smooth. This sensation persisted throughout the treatment but exam was unchanged. Patient was transferred to USC-LAC Dept. of Neurology.

TREATMENT #167 & #168

November 15, 1979

At 0800 two female (32 years old) divers started a dive off Ribbon Rock, Catalina Island intending to go approximately 80 FSW. After reaching 80 feet it was obvious to them that they had missed their intended location since no bottom was in sight. However, in spite of efforts to inflate her B.C. patient #1 continued to descend due to her heavy weight belt. Even with a fully inflated B.C. and strenuous kicking she was unable to stop her descent. At 130 FSW she experienced noticeable nitrogen narcosis but was able to drop her weight belt. With a fully inflated B.C. she now accelerated toward the surface. Patient #2 did not drop her weight belt but was able to swim to the surface attempting to keep up with her buddy. During the ascent, patient #1 apparently "blacked out" part of the time. However, at the surface she was conscious. The boat picked them up almost immediately. While climbing aboard, both divers experienced severe headaches. While still in the water and especially after getting on the boat, patient #1 reported lack of leg coordination as well as numbness. She layed down on the boat and found she could not move her legs. She also found it difficult to move her arms and reported pain in both arms.

Because of the high cliffs of the island, the skipper could not contact the Coast Guard by radio. He ran his boat to Catalina Harbor where he was able to contact Baywatch Isthmus. Upon examination by the Baywatch paramedics she was found to have weakness in both legs, notable with anterior flexion and most pronounced in the left leg. She had loss of proprioception in the great toes and sensory loss in her feet. She complained of inability to move her legs, numbness in legs and hands and a headache. There was no chest pain. Patient #2 appeared asymptomatic. Both patients were transported to the chamber by vehicle arriving at 0927. Both patients were placed in the chamber and compression initiated at 0930. They were treated on a standard Treatment Table 6A. At 165 FSW the patients were placed on the 53% N<sub>2</sub>/47% O<sub>2</sub> breathing mixture. Patient #1 showed substantial improvement at 165 and was asymptomatic after the first 20 minute O<sub>2</sub> period at 60 feet. Patient #2 was treated as a precaution due to her history and was asymptomatic during the entire treatment.

## TREATMENTS #164 and #165

Two males, #1, a 17 year old and #2, a 19 year old, were spear-fishing with scuba gear off a charter boat at Eagle Reef, Santa Catalina Island. Neither had a watch nor a depth gauge. At about 0930 they dove to approximately 45 feet for approximately 30 minutes. After a 15-30 minute surface interval, they dove to approximately 60 feet for about 20 minutes. #1 indicated that he had 500 psi showing on his gauge and #2 motioned that #1 should start up, but both divers were still putting speared fish in game bags. #1 started up but was overweighted with fish and could not manage to orally inflate his buoyancy compensator. #2 found #1 still on bottom with less than 200 psi showing on gauge. When #1 indicated that he was out of air, the pair began buddy breathing, but both had considerable difficulty ascending due to the heavy game bags. At about 30 feet, #1 broke away and made a panic ascent, apparently holding his breath. When #2 reached the surface, he vomited, then saw #1 on his back also vomiting. Then #1 passed out and #2 called for help. A diver from the charter boat arrived quickly and began mouth to mouth resuscitation. After 4 quick breaths #1 started thrashing and convulsing. After a few more breaths, #1 began breathing on his own.

When Baywatch arrived, they found #1 lying in a Boston whaler. He was cyanotic and hysterical and complained of substernal chest pain and frontal headache. #2 was picked up from the water, also hysterical and complaining of a headache (occipital). Both divers were put on O<sub>2</sub> and transported to the Catalina chamber. Since diagnosis for #1 was air embolism and for #2 possible air embolism, both patients were immediately recompressed to 165 feet. After 10 minutes both lost their headaches. #1 had rales on left side of chest, but after 1 oxygen period at 60 feet, lung sounds were clear bilaterally. At 60 feet, #1 was started on 5% Dextrose intravenously. After 3 oxygen periods at 60 feet and the slow ascent to 30 feet, the doctor was locked in to examine both patients. #1 was asymptomatic except for a ruptured left ear drum and mild epigastric cramps/gas pain. #2 was asymptomatic. Treatment on Table 6A was completed uneventfully. Both patients were held at Catalina overnight, then transported to USC-LAC County Medical Center by Sheriffs helicopter.



### Treatment #157

On 31 August 1979, a ~~25 year old male diving at~~ Little Farnsworth made a 110 foot dive for 10 minutes, then ascended to 90 feet for another 10 minutes, then took a 3 minute decompression stop at 10 feet. Patient has 10 years scuba diving experience and dives 30-40 times a month. He was diving with a buddy and had both depth gauge and a watch. A decompression meter was also worn.

Approximately 4½ hours post dive patient felt numbness and tingling in right fingers and hand, then he felt light headiness and blurry vision. There was some resolution within ½ hour. Patient was transported by Baywatch Avalon to Long Point, then transferred to Baywatch Isthmus arriving at the chamber 5½ hours post dive with much diminished symptoms.

Upon pressurization to 60 feet patient felt significantly improved and by 3 oxygen periods was asymptomatic. It was diagnosed as decompression sickness and treated on a straight Table 6. Patient was held overnight and by physician on site.

TREATMENT #148

29 June 1979

A 26 year old female was diving off San Pedro Pt., Santa Cruz Island: first dive was 60 ft. for 20 minutes, surface interval of 5 hours, second dive was to 50 ft. for 20 minutes. She became separated from her buddy but both surfaced and found each other. They then returned to the bottom and after 2 minutes again were separated. A third diver found the patient on the bottom unconscious. Estimates of her time of unconsciousness on the bottom ranged from 5 to 15 minutes. When brought to the surface, she was in cardiac arrest. Experienced CPR for 15 to 20 minutes established pulse and spontaneous respiration. She arrived at the Catalina Chamber 2:25 after being brought up. She was transported in a Coast Guard helo with paramedics aboard. Two amps of  $\text{HCO}_3$  and D5W were given during transport. At the chamber she was found to be in coma and unresponsive to all stimuli. She was immediately recompressed on a Table 6A: 30 minutes to 165 ft., (3) 20 minute  $\text{O}_2$  periods at 60 ft., and (11) 20 minutes  $\text{O}_2$  periods at 30 ft. At 60 ft. she was given Decadron (80 mg) and Aminophylline and showed an improvement in respiration. During the 4th  $\text{O}_2$  period at 30 ft. she opened her eyes in response to sternal rub but no other stimuli. Pupils were slightly reactive. No other change was noted during the rest of the treatment. She was transferred to Harbor General Hospital by Coast Guard helo.

TREATMENT 137

February 13, 1979

A U.S. Navy Altitude Chamber Inside Observer was on a training flight at the U.S. Navy facility at Pt. Mugu, Calif. The 19 year old male has made similar chamber flights 8 times per month for 10 months, with no problems. According to the training supervisor, the patient developed pain in the right hip and groin somewhere between 14,500 and 15,000 ft. This pain intensified to severe as they continued their ascent to 25,000 ft. One minute was spent at this maximum altitude and then they descended to sea level taking 10 minutes. They were on 100% O<sub>2</sub> by mask. At ground level, the patient still had the same pain along with numbness of the right foot. He was immediately transferred by U.S. Navy helicopter to the Catalina Chamber. He arrived at the chamber approximately 2 hours after the termination of his altitude chamber flight.

Upon examination he was found to have pain in the right hip with decreased sensation in the lateral aspect of the right foot. He was diagnosed as having decompression sickness with joint pain and a mild neurological deficit possibly secondary to local nerve injury. No evidence of spinal cord injury was found. As an extra precaution he was recompressed to 165' for 2 minutes before a standard treatment table 6. All of his symptoms were resolved during the descent to 165'. The rest of the treatment was uneventful with no recurrences. He was observed overnight and transferred to a U.S. Navy hospital.