

BASIC SCUBA LESSON 7

OBJECTIVES: By the end of today's class you will be able to:

1. Explain the most likely cause of lung over-expansion injuries.	2. List the four types of lung over-expansion injuries.	3. Briefly explain the causes, symptoms, prevention, and first aid for lung over-expansion injuries.
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How does Boyle's Law affect your body? P↑ V↓

1. Our lungs are like a sponge	2. Lungs are made up of millions of little sacs called alveoli.	3. Alveoli are one cell thickness membrane	4. Diffusion of O ₂ and CO ₂ .	5. Injury may occur by rupturing the alveoli which allows air into the blood vessels and in tissues of the body.
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Over Expansion Injuries	Cause	Physiological Explanation	Symptom	Prevention and 1 st aid
Air embolism - circulatory blockage; cerebral air embolism (blockage to brain).	Breath-holding while ascending	<ul style="list-style-type: none"> Air bubble into blood vessels. Air bubble larger than the vessel it will block circulation. 	<ul style="list-style-type: none"> Stroke-like symptoms Blood frothing mouth Staggering, confusion Sight loss Paralysis, collapse, convulsions, Stop breathing 	<ol style="list-style-type: none"> 1. Lie down 2. Administer O₂ - if qualified 3. Medical assistance - hyperbaric chamber 4. Resuscitate if necessary
Pneumothorax - collapsed lung		<ul style="list-style-type: none"> Air between the lung and inside of chest wall Does not allow the lung to fully inflate May cause lung to completely collapse 	<ul style="list-style-type: none"> Sharp pain in chest Shortness of breath 	
Mediastinal emphysema - air in chest in the vicinity of the heart		<ul style="list-style-type: none"> Air escapes from lungs into the chest May put pressure on the heart 	<ul style="list-style-type: none"> Pain under the chest, Faintness, shortness of breath 	
Subcutaneous emphysema - air under skin at neck		<ul style="list-style-type: none"> Air escapes from lungs Travels to underneath the skin "crackles" 	<ul style="list-style-type: none"> Feeling of fullness in neck, voice change, Difficulty breathing and swallowing. 	

What do you know?

<ol style="list-style-type: none"> 1. How are lung over-expansion injuries caused? 2. What type of injuries can we have from this? 3. What are some of the symptoms? 	<ol style="list-style-type: none"> 4. How do we prevent lung over-expansion injuries? 5. What do we need to do whenever the regulator is out of our mouths? 6. What is the first aid?
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1. Dalton's Law: In a mixture of gases each gas exerts a pressure proportional to the percentage of the total gas that is present. If O₂ represents 21% of the total gases in mixture at 1 atm then the P:O₂ at 1 atm is .21 (Pressure Table slide).
2. Henry's Law: The amount of a gas that will dissolve in liquid at a give temperature is almost directly proportional to the partial pressure of that gas. Responsible for Decompression sickness (DCS). If the P:O₂ at 1 atm = .21 then the amount of the gas dissolved in liquid is approximately .21.

	Causes	Physiological explanation: (Pressure Table Slide)	Symptoms	Treatment & Prevention
Decompression Sickness (DCS)	<ol style="list-style-type: none"> 1. Inadequate decompression following a dive. 2. Rapid ascensions. 	<p>The tissue and blood contain a certain amount of inert gas (nitrogen) in solution. This amount increases when a diver breathes compressed gases beneath the surface (Henry's Law). The human body can tolerate and remove, at atmospheric pressure and through the normal respiratory process, excess inert gas up to approximately double the normal amount. When saturation exceeds this limit, the diver must surface according to a decompression timetable, or risk decompression sickness. If the elimination of the inert gas falls behind schedule, the gas will come out of solution in bubble form in the blood and tissue. Depending upon their number, size and location, these bubbles may cause a wide variety of symptoms, including pain, paralysis, unconsciousness, and possible death. Bubbles forming in muscle tissues tend to move toward and collect at the joints. Bubbles forming in the blood can cause nitrogen embolisms with symptoms and effects identical to an air embolism.</p>	<ol style="list-style-type: none"> 1. 85% of the decompression sickness cases normally appear within one hour of surfacing and 98% within 12 hours. 2. Local pain in arms and legs 3. Dizziness (the "staggers") 4. Shortness of breath (the "chokes") 5. Extreme fatigue and pain 6. Collapse with unconsciousness 7. Occasionally the skin may show a blotchy and mottled rash 8. Itching or burning of a localized area of the body 	<ol style="list-style-type: none"> 1. CPR, Treat for shock, & O₂. 2. Prompt recompression in a recompression chamber (Westchester Medical) 3. Divers Alert Network (DAN) 919-684-8111 4. Plan to dive carefully, checking US Navy Standard Air Decompression Tables to determine if decompression stops will be required during the ascent. 5. Do not exceed the normal ascension rate of 30' per minute. On repetitive dives make safety stop (3 min. @ 15 feet). 6. Don't automatically assume that decompression sickness is impossible when using a single SCUBA tank. 7. Avoid contributing factors: poor fitness, drugs & alcohol, illness & injury, fatigue, and strenuous exercise (during & after dive).
Nitrogen Narcosis: The narcotic-like effect of excessive nitrogen pressure in the body	<p>Diving to a depth at which the N₂ tolerance of the diver is exceeded. Symptoms begin to appear in most divers at a depth of approximately 80'.</p>	<p>Physiological explanation: Unknown. Individual susceptibility varies.</p>	<ol style="list-style-type: none"> 1. Loss of judgment and skill 2. False feeling of well-being 3. Lack of concern for own safety 4. Difficulty accomplishing even simple tasks 5. Near unconsciousness in highly susceptible divers at great depths 	<ol style="list-style-type: none"> 1. Ascend to a shallower depth, symptoms will disappear rapidly. There are no after-effects. 2. Dive no deeper than what you trained, use buddy system, and ascend when symptoms first occur

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	Causes	Physiological explanation: (Pressure Table Slide)	Symptoms	Treatment & Prevention
Oxygen Poisoning	Partial pressure of oxygen in the body exceeds an acceptable limit	The mechanism is unknown; however, this accident occurs when the partial pressure of oxygen is 1.6 atmospheres (218 fsw). It is felt that excessive oxygen in the system has a detrimental effect on cell metabolism	<ol style="list-style-type: none"> 1. Symptoms: Some are usually ignored 2. May be no warning symptoms before the onset of convulsions. 3. Muscular twitching (usually occurs first in the face). 4. Nausea & Dizziness 5. Abnormalities of vision or hearing 6. Difficulty in breathing 7. Anxiety and confusion 8. Unusual fatigue 6. Uncoordinated 	<ol style="list-style-type: none"> 1. Admin O₂ 1st Aid, medical Evac 2. Never breath pure oxygen below 25' of depth 3. The amateur should never use pure oxygen for breathing below the surface. Have scuba tanks filled with compressed air only. 4. Do not exceed maximum recommended depth of 130 feet. 5. Continuing education: Refer to a Nitrox/Enriched air that requires special training and equipment. Additional training may be gained through NAUI.

Approximate Partial Pressure									
(a) Depth (ft)	(b) Absolute Pressure (x/33+1atm)	(c) Absolute Pressure (psi)	(d) P:O2 (atm)	(e) P:O2 (psi)	(f) P:N2 (atm)	(g) P:N2 (psi)	(h) Time (80 cu') *SAC=1cu'/min (min)	(i) Volume (cu')	(j) Density (w/v)
0'	1	14.7	.21	3.09	.79	11.61	80	1	X1
33'	2	29.4	.42	6.17	1.58	23.23	40	1/2	X2
66'	3	44.1	.63	9.26	2.37	34.84	26.7	1/3	X3
99'	4	58.8	.84	12.3	3.16	46.45	20	1/4	X4
132'	5	73.5	1.05	15.4	3.95	58.07	16	1/5	X5
165'	6	88.2	1.26	18.5	4.74	69.68	13	1/6	X6
198'	7	102.9	1.47	21.6	5.53	81.29			
218	7.6	111.72	1.6	23.52	6.0	88.2			
231'	8	117.6	1.68	24.7	6.32	92.9			
264'	9	132.3	1.89	27.8	7.11	104.5			
297'	10	147	2.1	30.9	7.9	116.1			

Note: **O₂ poisoning** occurs when the P:O₂ = 1.6 atm

Dalton's Law (Partial Pressure): In a mixture of gases each gas exerts a pressure proportional to the percentage of the total gas that is present. If O₂ represents 21% of the total gases in mixture at 1 atm then the P:O₂ at 1 atm is .21.

Henry's Law (Absorption): The amount of a gas that will dissolve in liquid at a give temperature is almost directly proportional to the partial pressure of that gas. Responsible for Decompression sickness (DCS). If the P:O₂ at 1 atm = .21 then the amount of the gas dissolved in liquid is approximately .21.

Absolute Pressure (b) in atm = Partial Pressure of O₂ (d) + Partial Pressure of N₂ (f)

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Absolute Pressure (c) in psi = Partial Pressure of O₂ (e) + Partial Pressure of N₂ (g)