NCC Pediatrics Continuity Clinic Curriculum
Hyperbaric & Dive Medicine

Goals & Objectives:

- Sketch the equations of the basic gas laws
- Know sea level atmospheric pressure and how it changes with depth
- Identify contraindications to diving through history & physical exam
- Outline the pathophysiology of decompression sickness (the bends)
- Describe a hyperbaric chamber and its common applications

Pre-Meeting Preparation:

- Watch these videos
  - a Refresher on the Gas Laws
  - Overview of a hyperbaric chamber
- Read a review of the Basics of Dive Medicine
- Google and review a schematic of a hyperbaric chamber
- Read up on Carbon Monoxide poisoning

Conference Agenda:

- Review dive medicine cases
- Review basics of dive medicine
- Visit the Undersea Medicine Research Lab in Silver Spring, MD or your local hyperbaric oxygen provider
- Observe hyperbaric chamber demonstration

Extra Credit:

- Diving Medicine: A Review of Current Evidence (JABFM 2009)
- Decompression Illness (The Lancet 2011)
- The US Navy's Submarine Force (Navy.mil)
- Deep Submergence Rescue Vehicle (military.com)
- Hyperbaric Programs in the United States (Undersea & Hyperbaric Medical Society)

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Case 1

SGT Rambo, a 22-year-old male Special Forces Soldier, wants to attend the U.S. Army Special Forces Combat Dive Qualification Course (CDQC) and asks for a physical.

What would be potentially disqualifying conditions that you could detect by history and physical exam?

After being cleared, SGT Rambo attends the course and is now undergoing self-contained underwater breathing apparatus (SCUBA) training in the training pool and breathing compressed gas from tanks through a regulator.

On the second day of SCUBA, he conducted a shallow-water (shallower than 10 feet) dive and practiced 10-foot free-surface ascents (FSA) multiple times with no issue. He then moved onto the 50-foot FSA, taking breaths of compressed air prior to ascending to the surface with no air.

1) **Based on the gas laws, if SGT Rambo holds his breath from 50 feet deep to the surface, what do you expect to happen to his lungs? Which gas law(s) did you apply?**

2) **An inert gas is any gas unknown to affect metabolism, such as nitrogen and helium. These gases are expected to dissolve into the blood and tissues, moving toward equilibrium with the partial pressure of the inhaled gas. Some tissues achieve this equilibrium very rapidly, such as muscle, while others (nerves and adipose tissue) take much longer (hours) to achieve equilibrium with the inspired gas.**

3) **Based on the information above, answer the following questions:**

    a. **What inert gas is SGT Rambo breathing on SCUBA? What percentage of this gas is he breathing?**

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b. What is the partial pressure of this gas at sea level (1 ATA)? What is the partial pressure of this gas at 33 feet of sea water (fsw)?

c. Do you expect SGT Rambo to have more or less inert gas dissolved in his tissues at 50 fsw compared to sea level? Why? What gas law(s) are you applying?

d. What may happen to the inert gas in his blood or tissues if he ascends too quickly? What gas law(s) are you applying?

Case 2

Imagine you are at one of the following locations. Where is the closest hyperbaric chamber?

NH Camp Lejeune (Navy), Fort Leavenworth (Army), Minot AFB (USAF)

Rich Summer, a 16 year-old Caucasian male certified open water diver, was on vacation in Honolulu. He was diving for 3 days, with his deepest dive being a 118 fsw dive with a bottom time of 35 minutes. More than 24 hours after his last dive, on his third vacation day, after a night of drinking (5 beverages), he went for a SCUBA dive on compressed air with a maximum depth of 89 fsw and total bottom time of 53 minutes. He had an uncomplicated dive without any buoyancy issues (i.e. rapid, unintentional changes in depth) or abnormal ascent/descent rates. As he ascended, his dive computer alerted him that he had exceeded his maximum recommended bottom time for a no-decompression stop dive and, therefore, recommended a decompression stop for off-gassing of inert gas at 20 fsw for 13 minutes. After some prodding, he admits he may have rushed the stop and ascended because he was late for a party.

1) **Physiologically, what is the purpose of a decompression stop? What gas law(s) does this apply? How do divers determine if a decompression stop is necessary?**

2) **Skipping a decompression stop places a diver at increased risk for decompression sickness. What are additional risk factors for decompression sickness?**

You suspect decompression sickness and recall from your days in pediatric residency that you need to get him to a hyperbaric chamber and a dive medicine specialist. How do you locate the nearest hyperbaric chamber and dive medicine specialist?

Case 3

Timmy is a 4 year old male visiting Grandma with his 7 month pregnant mother. Timmy and his mother present to the Keller clinic at West Point one afternoon after one episode of emesis, a complaint of headache and confusion. Grandma lives in upstate New York and it is December so Timmy has been playing inside all day. He was active, playful and excited to go to Grandma's house before his parents dropped him off in the morning. In the clinic, Timmy is confused as to where he is, he still has headache and he is lethargic. Mother also complains of headache and reports normal fetal movement. Grandma stayed home as she is not very mobile and doesn't have a military dependent ID card anyway.

1) **You suspect carbon monoxide (CO) poisoning. What history, physical, and laboratory data would support that diagnosis?**

2) **What is the half-life of CO at various pressures?**

3) **What interventions do you recommend?**