

YOU'RE THE FLIGHT SURGEON

This article was prepared by Lt.Col. Robert Lehman, MHPA, USAF, MC, FS.

You're the flight surgeon, on leave, when you are suddenly presented with a 55-yr-old fellow flight surgeon having difficulty. Your scuba-certified friend—now your patient—has been in the ocean for a few minutes and is still on the surface when he develops some distress. With all the diving equipment attached, he reports that he is unable to breathe appropriately, feels panicky, and is abruptly exhausted. He decides that he cannot make the dive and returns to the boat. On initial examination, he appears very fatigued and anxious, yet is calm and rational. He complains that attempting to take a large breath seems to result in nonproductive coughing. After you help him back into the boat and remove his equipment, he is able to slowly shuffle to a seat and sit down. Your friend reports he feels fine as long as he sits quietly and takes shallow breaths. You ask him to take a large breath, and he indicates he gets a sharp chest pain and then begins coughing. His pulse is rapid and bounding, but well below 120 bpm. He appears mildly frightened, but there is no overt diaphoresis or cyanosis. He denies any pain anywhere except for an anterior chest pain with a deep breath.

1. What immediate diagnoses need to be considered?
 - A. Myocardial infarction.
 - B. Pulmonary embolism.
 - C. Pneumothorax.
 - D. All of the above.

ANSWER/DISCUSSION

1. **D.** You immediately consider all of the sudden, life-threatening conditions you can think of. His chest pain is only with a deep breath and there is no radiation. He is not in distress when sitting quietly. A heart attack seems unlikely.

A pulmonary embolism would be very concerning. You are aware that the classic triad of chest pain, shortness of breath, and hemoptysis is often not found in a pulmonary embolism (5). However, the patient is an active runner who has been careful to stay hydrated on this vacation and pre-dive. He has trouble taking a large breath or moving quickly, but he is okay if he breathes shallowly and does not move much. Pulmonary embolism is not excluded, but it is lower on your differential diagnosis list.

Pneumothorax is also considered but ruled out. The patient can breathe fine; he just cannot breathe quickly. The trachea is in the midline. Breathing from a scuba tank is under pressure, but the patient denies there was any sensation of too much pressure from the regulator. He had not left the surface of the water, which dismisses diagnoses like barotrauma and decompression sickness.

2. The boat is 10 miles from port. What should be the immediate next step?
 - A. Find a way to recall the other divers (who had already descended), and return to port.
 - B. Call the coast guard or other rescue organization.
 - C. Pursue more history.

ANSWER/DISCUSSION

2. **C.** With the immediate, life-threatening problems reasonably excluded, you obtain more history. The patient is a certified open-water scuba diver who had not dived for 4 yr. He reports that he is usually nervous and a little claustrophobic on the first dive of the day, but once he is in the water and diving, all the fears go away and he enjoys the dive. He spent the last 2 yr flying every week with the T-6 Texan II, thus wearing a helmet, mask, and visor, and indeed, he denies having the claustrophobic sensation as he prepared for this dive.

After donning the equipment on the boat and verifying he could breathe well from the regulator, he stepped off the boat into the ocean. Upon his first breath there was water in his mouth. He thought water must have gotten in due to the force of stepping off the boat. He took out the mouthpiece and shook out the water. Breathing seemed fine, until he put his face in the water, and then there was a small amount

of water mixed with the air. He purged the regulator, but the water was still present. He says it was like trying to breathe when you have an upper respiratory infection with copious postnasal drip or secretions. He didn't recall it being like this in the past. He pursed his lips hard, and tried again, but with each breath he still got water mixed with the air, and he began to feel panicky. He tried to ignore the water in the regulator and forced himself to stay calm.

He tried to join the dive party who were preparing to descend, but he could not tolerate the water in the regulator and could no longer control his panic. He took off the mask, removed the mouthpiece from his mouth, slowly swam back to the boat, and was helped up into the boat.

He tells you that as he started to remove his scuba tank, he thought he was having a panic attack, although he had never had one before. Then he looked down and saw a large split in the hose right where the mouthpiece joined the regulator. It was obvious to your friend that when he had tried to breathe with the mouthpiece underwater, water was inhaled along with the air. He says he was relieved that he at least had a justifiable reason for having panicked. The boat captain said he could quickly install a new mouthpiece onto the scuba tank, and he would lead him down to rejoin the group already diving.

3. Based on the additional history, what is the best course of action?
 - A. Call back the divers and return to port.
 - B. Tell him to call it a day for diving, and enjoy the sunshine on the deck.
 - C. Let him strap on a tank and go.

ANSWER/DISCUSSION

3. **C.** Since he now understands why there was water mixed with the air, your friend decides to continue diving. As there seems to be a simple explanation for his symptoms, you wish him well. With a new mouthpiece, he steps off the boat. After testing the mouthpiece with his face underwater, he tells you that his breathing is easy and dry. He starts to propel himself toward the front of the boat along with the boat captain, who is going to free dive down and notify the divemaster that your friend is descending to join them. But after only 30 yards or so, it is clear something is still wrong. He reports he can barely move his arms or legs and is extremely exhausted. He is panting with shallow breaths and says his heart is rapid again. He gets to the back of the boat, manages to sit on the step, but cannot climb into the boat with the equipment on. After the scuba tank is removed, he stands up with difficulty, and holding on the guardrail, makes it to a seat. As before, if he tries to take a deep breath, he is rewarded with nonproductive coughing. He tells you he feels very weak.

4. What is the diagnosis?
 - A. Hypoglycemia.
 - B. Salt-water aspiration.
 - C. Congestive heart syndrome.
 - D. Aspiration pneumonia.

ANSWER/DISCUSSION

4. **B.** Hypoglycemia seems unlikely, but you have the patient quickly drink a soda and there is no improvement. The sudden onset and the relationship to the attempted dive make congestive heart syndrome or some type of pneumonia unlikely. You are fairly sure the patient has salt-water aspiration. Unfortunately, you've always been a physician in areas far from the ocean. By recollection and intuition, it seems to you that aspirating salt-water is probably more physiologic and tolerable than fresh water aspiration, and if he just gives it some time, his lungs will reabsorb the water and he will be fine.

5. So, what are your thoughts now as you review to this case?
 - A. I don't know; the thinking makes sense to me.
 - B. You idiot; salt-water aspiration is serious.

Before you decide, there is more to this true case:

It is 2 h later and the boat has motored over to a second and shallower dive area so that the patient could try again to dive with the

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group. He ignores your recommendation to call it a day, saying "I paid \$200 for this, and I'm going diving." He said he felt tired, but as long as he didn't take a large breath, he felt "okay." "It is just a little water in my lungs," he explains. "It will reabsorb." He goes for the dive. He cannot exert any sustained activity, so he descends by deflating his vest and lowering himself hand-over-hand down the anchor rope. Once at the bottom, and with proper buoyancy in the vest, it only takes minimal actions to slowly follow the divemaster. After diving for about 35 min, the effort has thoroughly exhausted him and he ends the dive. His dive gauge shows the maximum depth was 25 feet.

Coughing, he struggles to get into the boat and is acting completely exhausted. It isn't far back to port, and after docking, you help him out of the boat with difficulty. His car is only 30 yd away, and you walk him to the car as rapidly as he can, open the back door, and he lies down on the back seat. That's when you both realize something is definitely wrong. He cannot breathe lying down, and instantly pops back up to sitting position. Actually, you quickly discover that he can breathe best when standing, but he is so exhausted that he wants to sit or lie. It is immediately clear to you what is wrong.

6. What is the diagnosis?
- Salt-water aspiration with apical sparing.
 - Acute pneumonia.
 - Pulmonary edema.

ANSWER/DISCUSSION

6. A. The instant recognition that he cannot breathe when lying is both reassuring and concerning. Since he can only breathe upright, he is functioning on apical breathing. This means that he has lost lower pulmonary function, and the only explanation that fits with the timing of the symptoms is the aspiration of the salt water.

You confirm your diagnosis by reviewing a scuba diving medical website (1), and he spends the rest of the day sitting upright in a deck chair. He is able to go to dinner that evening, the cough controlled as long as he walks slowly. He uses six pillows to prop himself nearly vertical in order to go to sleep. During the night, he eventually slides lower and lower, removing pillows as he goes. By morning, he is able to sleep without elevation. He is unable to do anything faster than a normal walking pace the second day. On the third day, he runs his normal 4 mi as though nothing has happened.

CONCLUSION

Salt-water aspiration syndrome might not be all that common or well known to physicians, having only been first described by Edmonds in 1970 (2). Salt water is hyperosmolar, and quickly draws fluids into the alveoli (3). Mild cases with coughing and normal oxygenation usually respond to observation over time. More severe cases can evolve over hours into intrapulmonary shunting and ARDS (acute respiratory distress syndrome) (1).

There have been reports during the past 10 yr of acute pulmonary edema associated with scuba divers and swimmers. Nearly all of these case reports have been in patients older than 45 yr, in colder water (55°F), and have usually occurred toward the end of a dive. Some of the patients were swimmers and were only on the surface. These cases have been termed immersion pulmonary edema and have usually responded to oxygen, diuretics, and time, though some deaths have occurred. The hypothesis is that stress causes failure of the pulmonary capillaries and leaks across the endothelial layer (4).

Considering the references cited, salt-water aspiration syndrome and immersion pulmonary edema might be variants of the same process or could be completely different entities with similar end-effects. Whether drawn into the alveoli by osmosis or pushed in by some unexplained physiologic process, the result is transudate flooding of the alveoli and inadequate oxygenation. Treatment options and expectations appear to be the same: a position to maximize air exchange, possibly oxygen and diuretics, and wait for the condition to resolve.

AEROMEDICAL CONCERNS

The onset of this syndrome would "ground" any military or civilian flyer until they have totally returned to their normal pre-aspiration condition. As there are no reported sequelae following recovery, a waiver would not be required.

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