SOARING Rx

BY DR. DANIEL L. JOHNSON

Breathing at High Altitude

1: Shortness of breath is *not* caused by lack of oxygen, and oxygen does not relieve it.

2: Going to a high altitude may cause shortness of breath – but this is *not* related to any oxygen lack that you may have.

3: People believe these statements to be incorrect, so when we feel severely short of breath, we make the wrong decision about our oxygen system's function, and fail to solve the real problem.

4: When we *feel* short of breath, feel anxious, we tend to breathe harder, and the underlying problem is made worse.

5: Hyperventilation is not a psychiatric condition: it's a *normal* response to certain situations. Understanding how it works will allow you to correct it and to fix the real problem, or get the right aid.

6: Severe shortness of breath with *activity* always means something's wrong physically, with heart or lungs.

Wally's First Wave Flight

Wally, like the rest of us, didn't normally think much about breathing. It just took care of itself. If he ran too fast, or too far, he started gasping for oxygen, and then he rested and it passed. However, he didn't run very much – he'd rather be in the *chaise longue* posture, idly twiddling his fingers on a glider's stick, skipping from one cloud to the next.

One windy winter Wednesday, he visited friends at a mountain gliderport. They helped him tuck into a Schweizer 1-26 with oxygen, after having filled the bottle and tested the system. It was a windy day. As he was about to close the canopy to take the tow, his friend Wayne said, "Wally, have you ever flown rotor?"

"No, why?" The tow plane was taxiing into position; Jim was walking toward him with the tow rope.

Wayne glanced at them, and not willing to interrupt, said simply, "Well, if it gets too rough, just release and fly back."

The tow was indeed rough, but not beyond his skills. It was fun, and challenging. The lift seemed broken, so Wally felt he'd have a short flight. He released after about 3000 feet, and struggled

around for half an hour, climbing a few hundred feet, losing fewer hundred, gaining net altitude slowly.

Suddenly everything got very smooth. The vario showed about 3 knots up. In just a few minutes, he climbed past 12,000, and turned on the oxygen. He'd placed the cannula before he took off, of course. An electronic sensor put a little snort of air through the tubing each time he inhaled. *Pretty neat,* he thought, *I know it's working.*

By working to stay in the best lift he was soon at 17,000 ft, to avoid Class A airspace, he explored to find sink, then flew back and forth, descending and climbing in the wave. It was exhilarating!

Soon something strange began to happen. He started feeling short of breath. *Is the oxygen not working properly?* He wondered. He checked the pressure gauge, looked at the fittings he could see, felt the little snorts of air when he inhaled. *Maybe something's gone wrong with the sensor or the electronics,* he thought. Maybe it's just pressurized air. He began to worry.

The shortness of breath got more noticeable. A metallic taste appeared in his mouth. His lips began to tingle. He felt a little dizzy and spacey. *Geez, something's really wrong,* he thought. *I had better get this thing on the ground!* He was close to the gliderport, so he pulled spoiler until he'd flown into sink, and descended as quickly as he reasonably could. His fingertips were buzzing, and when he stretched his legs against the rudders, he felt little cramps in his legs and feet.

In the pattern, it took conscious effort to figure out just how and where he should be flying. His thinking was clear, but a bit slow.

After he landed, it took more than half an hour to feel better. He wandered around until he found Wayne and said, "You'd better check that O2 system. I didn't feel so good." Wayne listened to the story, and then said, "I'm sure the oxygen system is OK. I'm sorry you had this trouble. You were hyperventilating."

What is "hyperventilation"?

This word might make you think of an over-wrought flaky female huffing into a paper bag. This would be wrong, for "nerves" aren't the main cause, and it's not related to sex. First, we have to be clear that this word has two meanings:

1 – *Physiological hyperventilation.*

This is unconscious, and simply means that either the depth of lung ventilation *or* the rate, or both, is excessively ventilating the lungs. This often happens, and is normal:

- **Talking continuously** often requires more breathing than our body needs. Once I picked up a fun hitchhiker, and we told each other funny anecdotes. At the end of one long story, I was lightheaded and tingly. Or reading aloud to grandchildren who have cannily picked a long story to delay bedtime.
- **Thinking about exercise** causes preparatory hyperventilation.
- **Beginning to exercise** (stretching muscles increases breathing).
- Any exercise in an out-of-shape ("**deconditioned**") person causes inappropriate physiological hyperventilation. Athletes do not do this; in fact, conditioned athletes don't get terribly short of breath; they bonk before they get breathless. ("Bonk" == to exhaust the body's fuel reserves.)
- **Pregnancy** (relevant only to females, except when she breaks the news to him).
- **Emotion**. Both happy and sad emotions cause physiological hyperventilation.
- Any disease state that increases **lung or chest stiffness**.

Physiological hyperventilation is due to increased *ventilatory drive*, managed by the brain's respiratory center (since you want to know, the inspiration center and the expiration center flank the reticular activating system in the medulla, acting alternately in largo rhythm).Things that increase this drive include

- Increased carbon dioxide pressure in the blood (hypercarbia)
- Increased acids from exercise or other increased metabolism (acidosis)
- Extremely low oxygen pressure in the blood (hypoxia)

2 – *Clinical hyperventilation.*

By "clinical," I mean something that is abnormal and distressing. It is what we *feel*, and is not closely connected with

what the respiratory center is sensing. The *sense* of shortness of breath ("dyspnea") is affected most strongly by:

- Increased carbon dioxide pressure in the blood (this also causes a feeling of claustrophobia if we're in an enclosed space at the time)
- Lung or chest stiffness
- Central ventilatory drive in excess of the chest's and lungs' ability to pump air. This occurs mainly in lung disease, heart disease.
- The condition called "hyperventilation syndrome." In this condition, it's as if the midbrain sensor flips into backwards mode when the pressure of carbon dioxide in the blood falls from a normal value of about 40 mm Hg to under about 25 mm Hg. In this condition, the blood is more alkaline than normal, causing the electrical membranes of the nerves and muscles to malfunction. This is basically static, causing felt tingling or buzzing, or crampy muscles.

The Risk of Hyperventilation

The risk is mostly that we need a functioning brain while flying, especially while maneuvering.

- Hyperventilation *constricts* the arteries in our brain and *decreases* brain oxygen even if we're using the O_2 system. The reduced CO2 pressure *increases* peripheral oxygenation and *decreases* brain oxygenation. This means that your finger oximeter may have a fine reading, but your brain's oxygen supply is actually low.

So suppose you are flying at 14,000 ft, with your oximeter on for safety. Without oxygen, you will see that its reading has decreased from 97% saturation at sea level to a low value of 66%. Your brain's oxygen level has fallen from about 40 mm Hg to about 25 mm Hg – and we pass out at about 17 or 18 mm Hg.

Instead of turning on the oxygen, you take some nice deep breaths for a couple of minutes (hyperventilation), and the oximeter's reading climbs reassuringly to 96% – but *the brain's oxygen level falls to about 22 mm Hg*. This is not the direction we were hoping to go, is it? Low CO2 levels cause constriction of the cerebral arteries. This decreases glucose and oxygen delivery to the brain, which impairs thinking, leading to "errors of cognition" (the leading cause of crashes), such as forgetting what you learned from this article.

- The anxiety and fear (and the muscle cramping) are very distracting; distraction decreases pilot performance and fear freezes mental processing.
- In the pilot with unknown coronary heart disease, hyperventilation constricts the heart's arteries, and has sometimes caused complete occlusion (== "heart attack"). The cockpit is not the best place for this to happen, and please don't try to do a spot landing on the hospital's helipad.

The Breath Cure

Wally's shortness of breath was due to three factors:

- The delight of flight;
- The normal, unconscious increase of ventilatory drive with mild hypoxia;
- His worry when he started to feel short of breath.

These combined to create unintentional, unconscious over ventilation of his lungs. Because there's essentially zero carbon dioxide in the air around us, over breathing blows off CO_2 – this makes our blood more alkaline, altering nerve and muscle excitability, and, unchecked, creates a vicious cycle.

The cure is simple, if we only understand what to do: breathe less. Recycle our CO_2. We can do this by breathing through a tube, breathing into paper bag, or simply deliberately breathing more shallowly or more slowly, or holding our breath for 15 or 20 seconds at a time.

How this Works

OK, you want to know, don't you? In addition, I want to explain. However, I think this column is long enough already. Google "physiology of breathing," "regulation of respiration," or "pathophysiology of hyperventilation." (Technically, "*ventilation*" is what the lungs are for and "*respiration*" is what the mitochondria do in each cell, transferring electrons from the carbonaceous compounds we eat to oxygen, creating CO_2 and H_2O.)

Thanks to Paul Kram, Paul Randall, and Ingrid Nelson for helpful suggestions. It was hard to be succinct.