20 Questions – Respiratory Monitor

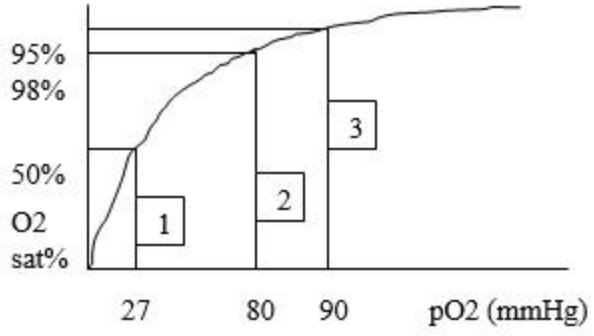
1. While on the scene of a 'heart', you ask the paramedic student for the pulse oximeter; he refuses to hand it over until you tell him how it works…What do you tell him? OK, well, how would you explain it if you weren't so crabby?
2. Once on, the probe reads 98%. Is this a normal O2 sat?
3. Is there much difference between a sat of 95% and 98%?
4. Coming down the stairs, the sat monitor falls off the stretcher and two flights down. How will you assess the patient's ventilation now that you've lost your oximeter?
5. How good is the clinical exam at determining hypoxemia?
6. You are called for one unconscious. Arriving, you find a thirty-something male deeply unresponsive. His oxygen saturations are 85% on room air, but rise to 97% with O2 by non-rebreather mask. Are his ventilations adequate?
7. What technology may assist us with determining adequacy of ventilation?
8. After clinical assessment reveals the patient is not breathing, he is intubated. What can cause false positive end-tidal CO2 readings?
9. You swear you saw the tube pass through the cords, but the EtCO2 is zero – did you miss?
10. A child has ingested artificial nail remover. Her skin is cyanotic, and your oxygen saturations are 85% both before and after 100% oxygen. What is probably going on?
11. Several victims are pulled from a house fire with decreased levels of consciousness. All have oxygen saturations in the normal range. Why should you still worry about oxygen delivery to the tissues?
12. One of these patients has red nail polish on, and you cannot obtain a sat reading. Is this a likely color to create major interference with the sat probe?
13. An infant is having difficulty breathing, and is cyanotic. O2 sats are in the low 80s before O2 and do not improve with 100% oxygen. What may be going on?
14. What is the best location to monitor oxygen saturations in an infant?
15. What are some additional factors that can cause errors in the oxygen saturation calculations?
16. You are having trouble getting a probe to read despite several adjustments in position. If it is daytime, and you are outside, what may be a factor?
17. If a patient is very anemic (low hemoglobin), how much can they use the dissolved oxygen in their blood?
18. Is there a danger to supplemental oxygen?
19. What are the concentrations of oxygen that can be given by nasal cannula, simple face mask, and non-rebreather mask?
20. Can you trust an O2 sat reading that seems to stay relatively constant without a good waveform?

20 Answers – July 2016 – Respiratory Monitor

1. A pulse oximeter works by measuring the absorption of two different wavelengths of light (red and infrared) by *arterial* blood. The light passed through the blood is absorbed more or less depending on the amount of oxygenated and deoxygenated hemoglobin. By making a ratio of the absorption, and comparing it to internal standardized ratios, the oximeter can calculate the fraction of hemoglobin that is carrying oxygen (far faster than you can). In the

stabilization room, we use a transcutaneous tissue oximeter to measure capillary oxygen levels (which help determine if the tissues are actually getting enough oxygen delivered, rather than how much is in the blood overall).

2. Yes, 95-100% is considered normal. However, some people with COPD and other lung diseases may have lower saturations that are 'normal' for them (and indicate advanced disease) – in this case, their 'normal' may be in the upper 80s or low 90s and correction to 99% may be hazardous as it will reduce their respiratory drive.
3. Yes – the oxygen dissociation curve gets pretty steep pretty fast. Point 1 is where a decrease in pO2 (oxygen dissolved in blood) means a decrease in sat, points 2 and 3 are at about 95% and 98% respectively, and you can see that points above #3 on the curve might well have a saturation of 98-99% but are significantly different in terms of how much oxygen is really being carried. Note how fast the actual oxygen available falls off as the sat declines past the upper 80s/low 90s!



4. Look at the respiratory rate, effort, (including accessory muscle use and extra sounds (grunting, etc.), lung sounds, presence of cyanosis, nasal flaring, agitation, diaphoresis, and other signs of respiratory distress, and don't forget to ask the patient how they feel they're breathing…
5. Poor. Studies of both docs and paramedics show that except in severe cases, we don't pick up the majority of persons that are hypoxemic. One paramedic study showed that 90% of hypoxemic patients (sat < 95%) were missed overall.
6. Never use oximetry to determine respiratory adequacy. Oximetry can tell you when ventilations are INadequate (when hypoxemia exists), but cannot tell you if they are adequate. Patients with minimal respiratory efforts may be coaxed into a 'normal' sat with enough oxygen, but are still hypoventilating and possibly becoming acidotic from build-up of CO2. Respiratory adequacy depends as much on getting the 'bad air out' as it does 'getting the good air in'. You can frequently give high flow oxygen and get normal sats, but the patient is still in respiratory failure requiring intubation or other interventions.
7. Glad you asked! Side-stream CO2 monitoring can help us a lot. The cannulas can be used on spontaneously breathing patients, particularly overdose or other patients where you are worried about adequacy of respirations, and not just oxygen delivery. Transcutaneous oxygen and carbon dioxide monitoring systems are likely be coming to EMS soon
8. If the patient overdosed on beer (or other CO2 containing beverage), this CO2 may register for a short period after esophageal intubation, falsely indicating correct placement in the trachea. Interestingly, (or not), calculation of the O2 sat is based partially on Beer's law. The irony…
9. Probably – unless the patient has been dead for awhile, there should still be some CO2 in the lungs – it's rare to have an absolute zero… and the higher the levels of CO2 being detected, the better the chance of return of circulation – rising CO2 levels can be a good indicator of restored circulation or at least good CPR…
10. Artificial nail remover may contain nitroethane, one of many compounds that can produce methemoglobinemia. Methemoglobin does not bind oxygen well. The absorption characteristics of MetHgb result in a sat of around 85%, regardless of the concentration of oxygen in the

blood. This is a dangerous poisoning, and requires treatment with methylene blue, a dye which helps to reverse the effects of the toxin and potential hyperbaric treatment.

11. Carbon monoxide poisoning causes hemoglobin to hold on to oxygen very tightly, which blocks its release to the tissues. Saturation basically looks at how much normal hemoglobin is saturated, but fails to consider abnormal hemoglobin. For example, if the carboxyhemoglobin level was 20%, the saturation would be based on the remaining 80% of hemoglobin, and could thus be a misleading 100%, despite relatively high levels of CO. Again, do not rely on the sat monitor to assure adequate oxygen delivery, only use it to assess for INadequate levels of oxygen.
12. No. Generally the 'First Avenue' colors black, green, and brown-red cause the most problems. If in doubt, remove the polish and try again.
13. Infants with certain types of heart defects (great vessel and valve abnormalities) may have shunting (mixing of oxygenated and deoxygenated blood), resulting in a sat that does not improve much with supplemental O2. Unless this child has methemoglobinemia, a low sat that doesn't respond to oxygen, coupled with cyanosis, is almost diagnostic of cyanotic congenital heart disease. Several of these problems are not usually found until a few weeks of age, long after the infant has gone home from the hospital.
14. Usually the great toe. Acrocyanosis, which can be normal in infants (cool, pale hands and feet) may prevent good readings there, in which case the earlobe (try rubbing it first), or bridge of the nose.
15. Acidosis, temperature extremes, and the presence of fetal hemoglobin (infants under 1 month) all may result in somewhat inaccurate saturations, though these are usually minor differences.
16. Sunlight. Intense ambient light (natural or flourescent) may interfere with the probe, by returning too much light to the sensor.
17. Not much. A sat monitor needs about 5g of hemoglobin to read. Again, if the hemoglobin is 6, the sat may be 99% but the tissue delivery of oxygen may still be impaired because there just aren't enough red blood cells to bring adequate oxygen to the tissues. Dissolved oxygen is only 1-2% of the total blood oxygen (the rest is bound to RBCs). Only under hyperbaric conditions is the dissolved oxygen high enough for the body to survive on (hence, it's the treatment for severe poisoning of the hemoglobin system).
18. The higher the amount of supplemental oxygen, the more free radicals that are generated which can damage tissues. We've moved away from giving mask oxygen to everyone to just trying to get the saturation in a normal range for this reason, as the outcomes in stroke, MI, and other conditions seem to be worse when high concentrations of oxygen are given. Assure your patient has enough oxygen (aim for 97-99%) but don't feel like you need to give more. The less stable the patient, the less you should worry about this issue and just get them the oxygen they need…
19. Though this is variable, think of these rough numbers: room air 20%, nasal cannula 30%, simple face mask 50%, non-rebreather 80%.
20. No. Remember question 1? The sat must be measured in arterial blood (since we can't really use a mixed venous sat measurement to guide therapy). Therefore, if the monitor doesn't pick up an arterial waveform (and heart rate doesn't correlate with patient's) it will tend to register toward 85% (if it registers a number). This is a default, and does not really represent the sat, which may really be lower or higher.

Enjoy the summer weather and road construction!