November 2016 Critical Care Case of the Month

Richard A. Robbins, MD

Phoenix Pulmonary and Critical Care Research and Education Foundation
Gilbert, AZ USA

History of Present Illness

A 45-year-old Iraqi War Veteran was seen in the outpatient clinic after referral for COPD based on abnormal blood gases. He denies any dyspnea or cough.

PMH, SH and FH

He has a history of a lower back injury and uses a motorized wheelchair. His pain is managed with morphine sulfate ER 60 mg daily and morphine sulfate 10 mg every 4 hours as needed for breakthrough pain.

He does not smoke cigarettes but does use marijuana for pain. He denies alcohol abuse.

Physical Examination

Physical examination shows a lethargic man in a wheelchair who intermittently falls asleep during questioning and examination. When aroused he is oriented to time, place and person and frequently mentions that his pain is a 10. His vital signs are normal except his SpO₂ is 75% on room air. His lungs were clear and his heart had a regular rhythm without murmur. His pupil size is approximately 2 mm bilaterally and muscle strength is difficult to determine due to his inability to remain alert or fully cooperate.

Radiography

A chest x-ray had been performed about a week previously (Figure 1).

Figure 1. Initial chest x-ray.

Spirometry had been performed earlier in the day (Figure 2).

Figure 2. Spirometry.

Which of the following are **indicated at this time?**

1. Arterial blood gases (ABGs)
2. Immediate intubation
3. Intensive care unit (ICU) admission
4. 1 and 3
5. All of the above

Correct!
4. 1 and 3

His chest x-ray and spirometry are normal but his low SpO₂ is worrisome. For this reason he is admitted to the ICU and his ABGs performed on room air are below.

PaO₂ 40 mm Hg
PaCO₂ 82 mm Hg
pH 7.12
HCO₃ 34 mEq/L
SaO₂ 76

What is the **cause of his low PaO₂ and SpO₂**?

1. Alveolar-capillary block
2. Hypoventilation
3. Right to left shunt
4. Ventilation/perfusion mismatch
5. None of the above

Correct!
2. Hypoventilation

All are causes of hypoxemia although alveolar-capillary block as a cause of hypoxemia at rest is controversial. The Alveolar-arterial (A-a) gradient in this patient is normal (1). This is calculated by first determining the PAO₂ (partial pressure of O₂ in the alveoli) obtained from the Alveolar Gas equation. The atmospheric pressure in Phoenix is about 747 mm Hg and the pressure of water vapor is 47 mm Hg at body temperature. Subtracting 47 from 747 conveniently gives 700 and multiplying 700 by 0.21, the atmospheric percentage of oxygen, gives 147 mm Hg. From this subtract $1.25 \times \text{PaCO}_2$ and the PaO₂ which gives an A-a gradient of 4 ($147 - (103 + 40) = 4$). This is normal based on normal being patient age/4 +4. Hypoventilation is the only cause of hypoxemia which results in a normal A-a gradient. The A-a gradient rises with age and oxygen administration.

Given the clinical situation what is the **appropriate treatment?**

1. Bicarbonate administration
2. High flow oxygen
3. Intubation and mechanical ventilation
4. Methylphenidate (Ritalin) administration
5. Naloxone (Narcan) administration

Correct!

5. Naloxone (Narcan) administration

The patient does not have COPD although that was the reason given for the original referral. COPD produces hypoxemia by ventilation/perfusion mismatch. The cause of his hypoventilation is most likely chronic narcotic administration and not a neuromuscular disease or morbid obesity. Unfortunately, while the respiratory therapist is running the arterial blood gases he is given oxygen initially at 2L/min by nasal cannula. When the SpO₂ on the pulse oximeter rises minimally the oxygen flow rate is increased to flood. The patient becomes apneic and cyanotic and a code blue is called. The patient is intubated and placed on mechanical ventilation. The patient is given naloxone and awakens becoming combative.

What should be **done at this time?**

1. Administer small doses of sedation to calm the patient
2. Extubate the patient immediately
3. Give small doses of morphine for sedation and to prevent narcotic withdrawal
4. 1 and 3
5. All of the above

Correct!
4. 1 and 3

Obviously things have not gone well. The high oxygen administration likely resulted in the apnea. After the patient was intubated and ventilated decreasing the PaCO₂, the naloxone administration resulted in a rapid narcotic reversal leading to the patient becoming combative. It is probably too soon to extubate the patient and sedation is indicated to manage him along with morphine to prevent narcotic withdrawal. This was done and he was extubated a couple of hours later.

He was transferred to the floor the next morning and discharged shortly afterwards on smaller doses of morphine. After picking up his prescriptions, he went to the patient advocate to complain about the lower doses.

References

1. <http://www.globalrph.com/aagradient.htm>
2. Girardis M, Busani S, Damiani E, et al. Effect of conservative vs conventional oxygen therapy on mortality among patients in an intensive care unit: the oxygen-icu randomized clinical trial. JAMA. 2016;316(15):1583-1589.
[\[CrossRef\]](#) [\[PubMed\]](#)