Respiratory System Case Study

History: A 68-year old male was admitted to the ER with dyspnea, cyanosis, and cough. The patient has a history of 300 packs per year and has been unable to quit smoking. The patient was hospitalized earlier this year with pneumonia.**Physical Exam**: Barrel chest, cyanotic skin, ankle edema. Dyspnea is apparent. Hyperresonance upon percussion of the thorax. Accessory muscle breathing.**Findings**:

BP: 180/105 mmHg

pulse: 125/min

resp: 30/min

temp: 98.6 degrees F

hematocrit: 60%

dead air space: 300 mL

TV: 500 mL

FEV1: 45%

pH:7.30

pCO2:51 mmHg=

pO2:43 mmHg

HCO3-: 35 mEq/L

1. Explain specifically why the patient has a barrel chest. Why there is hyperresonance upon percussion?

This 68 year old male exhibits barrel chest (emphysematous chest) due to Chronic Obstructive Pulmonary Disease, specifically, pulmonary emphysema. The alveoli located deep within the lungs, have undergone deteriation (most likely from the many years inhaling tobacco pollutants, which limits the surface area needed for ample oxygen and carbon dioxide exchange. (Bartholomew, 2018) Cigarette smoking is highly prevalent in patients with COPD in the United States, totaling eighty percent (Han, 2019). Barrel chest could also be evident depending on the patient's geographical location. Those "who live in high-altitudes consequently have increased vital capacity", which can cause "a large, rounded thorax" seen in individuals with barrel chest. (Han, 2019) Hyperresonance during percussion occurs because of the large amount of air existing in the tissues of the lungs. (Gwinnett Technical College, 2018a). Giant bollus or bollus emphysema develops from the trapped air with thin the alveoli. These can develop in and

around the diseased lung tissue (Mosby, 2013). The giant bollus produces hyperinflation can be seen in patients who are further along in the disease process. Barrel chest is caused by hyperinflation of the alveoli for persistent periods of time (Han, 2019). Essentially through hyperresonance we are tapping on the alveoli drum, introducing the emphysema.

2. What term best describes the respiratory rate? If it is abnormal, explain why. In your answer be sure to discuss the anatomy and physiology in detail.

This male has an abnormal respiratory rate of 30 breaths pee minute. He is showing signs of tachypnea because his breaths are more than eighteen breaths per minute. Loss of the elastic fibers: therefore reduces the “passive tissue recoil”. With out the elastic tissue, expiration and appropriate ventilation cannot occur. Proper functioning of the septal lung cells (type II alveolar cells) is important for surfactant production that makes expansion easier. COPD destroys the alveoli that in turn negatively impact the septal cells and the expansion needs for sufficient pulmonary ventilation. (Gwinnett Technical college, 2018a, p.143). This is clinically significant because his body is attempting to make up for the lack of oxygen in the blood. Therefore, the patient struggles to breath more frequently to retrieve more oxygen but it actually just increases the carbon dioxide in the blood. This produces tachypnea (Bartholomew, 2018, p.877).

3. Calculate the patient’s MVR and AVR. In your answer include the equations for each and show your work for each calculation. What is the significance of the AVR?

The patient’s minute volume of respiration (MVR) is 15 liters per minute; which is abnormal. During relaxation the normal respiratory minute volume is around 6 liters per minute (Bartholomew, 2018).

MVR= (breaths per minute) X (tidal volume)

=30 breaths per minute X 500 mL

=15000 mL per minute

=15.0 liters per minute

To convert mL to Liters you divide by one thousand and would get 15 Liters per minute (Gwinnett Technical College, 2018a).

The patient’s alveolar ventilation rate (AVR) is 6 liter per minute. During relaxation the appropriate alveolar ventilation rate is 4.2 liters per minute. (Bartholomew, 2018).

AVR= (breaths per minute) X (tidal volume-dead space)

= 30 breaths per minute X (500mL -300mL)

= 30 breaths per minute X 200 mL

= 6,000 mL per minute

= 6.0 liters per minute

We account for the dead space when calculating the AVR, which is why it will always be lower than the MVR; however, in these patients' findings we can conclude both values are abnormal due to the increased effort they have to make just to breath a normal amount of oxygen in at rest (Gwinnett Technical College, 2018a, p.148). AVR is high due to the "hyperinflation observed in the physical examination of the patients barrel chest" (Han, 2019).

4. What term describes his blood pressure? If it abnormal, explain why. In your answer, be sure to discuss the anatomy and physiology in detail.

This patient's blood pressure would be considered stage two hypertension because the systolic number is higher than 160 mmHg and diastolic is higher than 100 mmHg (Mosby, 2013). COPD in its later stages can leave the patient with cor pulmonale or pulmonary hypertension. (Han, 2019). Possibly from having untreated high blood pressure for too many years. Pulmonary hypertension can cause an increase in pressure through the capillaries that are carrying blood from right side of the heart and back to the lungs. The upsurge in PCO2 arouses the chemoreceptors; which therefore, increase the cardiac output, respiratory rate, and blood pressure. (Bartholomew, 2018).

5. What term describes his pulse? If it is abnormal, explain why. In your answer, be sure to discuss the anatomy and physiology in detail.

A pulse that stays above 100 beats per minute would be described as tachycardia. The chemoreceptors on the medulla oblongata actually bring up the heart rate to bring more oxygen to cells in the body. This escalates the amount of oxygen though out the entire body. (Mosby, 2013). Those same chemoreceptors that increase blood pressure stimulates "the airway stretch receptors" which "triggers the inflation reflex, but also increase heart rate." As the cardiac output continues to go up so does the blood flow in the alveolar capillaries. (Bartholomew, 2018). This produces a rapid heart rate seen in this patient's examination.

6. Give a detailed explanation of why this patient has ankle edema. In your answer, be sure to discuss the anatomy and physiology in detail.

The pulmonary hypertension that was briefly mentioned in reference to the patient's blood pressure in question number 4 is also a possible cause of the ankle edema. This edema is the results from disproportions of osmotic and hydrostatic pressure with thin the capillaries. Diffusion of ions, filtration of solutes and the reabsorption of water cannot occur like they normally do which results in build of interstitial fluid. Because reabsorption is not taking place the "fluid moves out of the blood and builds up in peripheral tissues." Ankle edema is a classic clinical finding in pulmonary hypertension that can end in right-sided heart failure (Bartholomew, 2018, p.744).

7. Is the hematocrit normal? In your answer, be sure to discuss the anatomy and physiology in detail.

A hematocrit of 60% is high considering the average range is 46% in males. His many years of smoking produce carboxyhemoglobin that leaves this patient with the effects of hypoxia. Considering this patient is in the late stages of COPD, it would be correct to say that the low oxygen being exerted on the tissues is causing hypoxia which in turn causes polycythemia. The hematocrit can fall because of the formation of red blood cells. The cyanotic skin exhibited

during his examination supports hypoxia. All factors contribute to the above abnormal hematocrit seen in these patients' findings (Bartholomew, 2018,p.659).

8. Why did the hospital run an FEV1 test? Is the patient's FEV1 normal? If it is abnormal, explain why. In your answer, be sure to discuss the anatomy and physiology in detail.

The FEV is performed to determine the severity of the patient's lung disease. The patient breaths into a spirometer that is attached to equipment to measure exactly how much air can the patient can expire after taking a deep breath. This patient FEV is not normal because it is far below the 80% we would like to see. This is due to the bullae in his lungs that are trapping the air. This can be supported by the 300 mL of dead air space we see in his findings. He cannot take in a lot of air on inspiration so he doesn't have much to exhale. A low FEV is indicative of a breathing obstruction. He is in the severe stage of COPD because his FEV is between 30-49% (Cirino, 2017).

9. Which artery was likely used to obtain the arterial blood gases?

The best artery to draw arterial blood gases from is the radial artery (anatomically it is located on the thumb side of the wrist) because it provides straight arteries that bring blood to the basal layer of the endometrium. This is close to the surface, which makes it easiest to obtain blood from. This is also go to artery because it is the safest compared to the femoral and brachial artery in terms of bleeding. All can be used to draw arterial blood from but the radial artery is most likely to be used (Bartholomew, 2018, p.1078).

10. Which acid-base imbalance disorder is apparent from the results?

The acid based imbalance disorder that is apparent from the findings is the low blood ph. of 7.30. This should fall between 7.35-7.45. Even the smallest change in blood ph. can result in respiratory acidosis. This was caused by a rise in partial pressure of carbon dioxide in the blood, known as hypercapnia. This patient PCO2 is 51 mmHg and it should fall between 35-45 mmHg. This diagnosis is supported by the increase in breathing rate seen in his findings. The chemoreceptors that check the PCO2 in the blood quickened the respiratory rate. If the partial pressure of oxygen remains too low and the partial pressure of carbon dioxide remains too high for an extended amount of time the chemoreceptors will actually reset them selves to those number. And they loose their opportunity to return the levels back to normal. (Bartholomew, 2018, p.874).

11. What term describes the amount of carbon dioxide in the blood? If it is abnormal, explain why. In your answer, be sure to discuss the anatomy and physiology in detail.

This patient how ever has chronic respiratory acidosis because his compensatory means have not crashed yet. The ph. has only shifted to the left a little because the kidneys have slowed the ph. change down by releasing H+. Unless the pulmonary obstruction is surgically fixed by removing the bullae or brochondilation is induced by mechanical or medicinal means or drugs the kidneys cannot alone fix the respiratory acidosis. And bring the ph. back to normal range. The buffer systems take in some H+ but once it has been surpassed the blood ph. falls. Eventually he could develop complementary metabolic acidosis and make lactate acid and h+ secretion (Bartholomew, 2018, p.1045).

12. Is the level of bicarbonate in the blood normal? If it is abnormal, explain why. In your answer, be sure to discuss the anatomy and physiology in detail.

Hypercapnia is the best description of carbon dioxide levels in the blood. This patients findings reveal insufficient “tissue perfusion” which causes the hypercapnia in the blood. This patient does not have a normal level of bicarbonate in the blood. The normal level should fall between 23-30 mEq/L in adults; but his however, is above that at 35 mEq/L. HCO3- is high in this patients blood because of the hypercapnia and “inadequate tissue perfusion” (Han, 2019). The low blood ph seen in his findings is what stimulates the kidneys to produce the extra bicarbonate we see in his findings. The greater the respiratory acidosis is the greater the kidneys attempt to compensate for the low ph. The arterial blood gases seen in his findings support this diagnosis (Bartholomew, 2018, p.876).

13. What word describes the level of oxygen in the blood? If it is abnormal, explain why. In your answer, be sure to discuss the anatomy and physiology in detail.

A normal level of partial pressure of oxygen in the blood is 105 mmHg and this patient has 43 mmHg of partial pressure of oxygen in his blood. The best way to describe this patients low oxygen levels in the blood is hypoxic. The low oxygen in the lungs from disease creates the hypoxia. Lactic acidosis could result from many years of hypoxia. (Bartholomew, 2018, p.665, p.1047). The accessory muscle breathing seen in his physical examination is an attempt for the body to develop positions that relieve the hypoxic state, and dyspnea the patient is experiencing (Han, 2019). The patient’s lung compliance has increased because of the rise PCO2 in the blood allowing the hemoglobin to give the oxygen more easily. The air goes in and out of the lungs more easily, which causes the patients dyspnea and accessory muscle usage. (Gwinnett Technical College, 2018a, p.154)

14. What is a likely diagnosis for this patient? Why did this condition develop?

Through analysis of this patients history, physical exam, and findings he is diagnosis with Chronic Obstructive Pulmonary Disease, specifically, pulmonary emphysema. He has two of the most seen symptoms with COPD, which are cough and dyspnea. On average “62 percent of patients have these symptoms” (Han, 2019). This was caused by his unsuccessful attempts to quit smoking 300 packs of cigarettes a year. He was recently hospitalized with pneumonia because his respiratory defenses have been compromised. His blood air barrier isn’t working to prevent such infections (Bartholomew, 2018, p.848). Because we are not given the geographical location f the patient we cannot rule out the possibility of high altitudes be a contributing factor in this patients condition.

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