Case Studies: Restrictive and Obstructive Respiratory Conditions

Case Study # 1

Jenny Smith, a 14-year-old girl with asthma, had been under relatively good control until last night. She slept over at a friend's house and woke up in the middle of the night with severe shortness of breath ("dyspnea") and a cough (unproductive of sputum). She had expiratory wheezing. Unfortunately, she did not take her bronchodilator medication with her to her friend's house. She was taken to the emergency walk-in clinic. On physical exam, she was wheezing quite loudly and using her accessory muscles of respiration to help her breathe. A chest X-ray revealed hyperlucent and over-inflated lungs. Blood testing revealed an arterial blood pH of 7.25 (normal = 7.35-7.45). Pulmonary function testing revealed the graph shown (Pre-Bronchodilator).

Questions:

Based on the graph, fill in the following data:
1. tidal volume ____________
   inspiratory reserve volume ______________
   expiratory reserve volume ______________
   forced vital capacity _____________
   residual volume ______________
   FEV1 ______________

2. What is her FEV₁ / FVC ratio? __________

3. Does this ratio indicate restrictive or obstructive lung disease and why?

4. What is the condition that caused Jenny to come to the emergency clinic? Explain this condition.

Note: 1cc = 1ml; For the above graph use 125 cc per box to record data.
5. Explain why Jenny’s chest X-ray revealed hyperucent (i.e. excessively dark) and over-inflated lungs? Hint: Note her residual volume

She is given a bronchodilator called theophylline that makes her breathe more easily, after which pulmonary function tests are repeated (Post-Bronchodilator). Describe the changes in her breathing.

6. Based on the graph, fill in the following data:
   - tidal volume ____________
   - inspiratory reserve volume ____________
   - expiratory reserve volume ____________
   - forced vital capacity ____________
   - residual volume ____________
   - FEV1 ____________

7. What is her FEV$_1$ / FVC ratio? ____________

8. Describe the reasons for the changes in her residual volume, forced vital capacity, and FEV1/FEV ratio.

9. Why was her arterial blood pH lower than normal? What is this condition called?
Case Study #2

Joe Smith is a 69-year-old male with a 50-year history of smoking 2 packs of cigarettes a day (i.e. 100-pack-year smoking history). Over the past 5 years, he has become increasingly short of breath. At first, he noticed this only when exercising, but now he is even short of breath at rest. Over the past two years, he has had several bouts of lower respiratory tract infection treated successfully with antibiotics. His shortness of breath hasn't subsided, and his breathing is assisted by use of his accessory muscles of respiration. Pulmonary function testing revealed the following graph:

Based on the graph, fill in the following data:
1. tidal volume ____________
   inspiratory reserve volume ____________
   expiratory reserve volume ____________
   forced vital capacity ____________
   residual volume ____________
   FEV1 ____________

Note: 1 cc = 1 ml;
For the above graph use
125 cc per box to record data

2. What is the FEV$_1$ / FVC ratio? ____________

3. Does this ratio indicate restrictive or obstructive lung disease and why?

4. What condition would you diagnose the patient with?

5. What is the cause of the elevated residual volume?
3. Describe the microscopic changes occurring in Joe's lungs. Explanation should include information about macrophage/neutrophils and what they produce as well as the effects of alpha-1 antitrypsin.

4. What effect do these microscopic changes have on Joe's ability to transfer oxygen and carbon dioxide in the lungs?

5. Blood testing showed Joe's hematocrit to be 59% (normal = 42-54%). Why was his hematocrit so high? Explanation should include a description of the physiological mechanism involved in raising his hematocrit. Hint: kidneys.
Arterial blood tests revealed the following:

\[ pO_2 \] (partial pressure of oxygen in the plasma) = 73 mm Hg (normal = 80-105 mm Hg)
\[ pCO_2 \] (partial pressure of carbon dioxide in the plasma) = 50 mm Hg (normal = 35-45 mm Hg)
\[ pH \] = 7.32 (normal = 7.35-7.45)
\[ Hb-O_2 \] sat (hemoglobin-oxygen saturation) = 84% (normal = 95-98%)

6. Why was Joe's \[ pCO_2 \] increased above normal?

7. Why was his arterial blood \[ pH \] below normal? Is this due decreased \[ pH \] due to respiratory or metabolic acidosis?

8. Joe's \[ pO_2 \] is clearly below the normal range. One's first instinct might be to give him air to breathe that is 100% oxygen. Why would this be dangerous for him? Elaborate on what happens to \[ CO_2 \] and \[ H+ \] sensory receptors exposed to chronic high levels of \[ CO_2 \] and \[ H+ \].

9. Why is Joe susceptible to lower respiratory tract infections?