TUSPM Physiology Examination RESPIRATORY PHYSIOLOGY Wednesday, October 20, 2010

This examination consists of <u>30</u> questions on <u>7</u> pages. Please be advised that some questions may have a block of answers that correctly fulfill the question (For example, "all of the above"). Please mark your answers clearly on the answer sheet.

Questions 1-6 <u>ONLY.</u> Mr. Hackenkoff has been a heavy cigarette smoker for many years. He is now experiencing dyspnea after ascending a short flight of stairs. Upon examination, his pulmonologist noted a barrel chest and cancerous lesions in the pharynx. No cancerous areas were detected in the lungs. Values from Mr. Hackenkoff's respiratory work-up are presented in Table I, below:

TABLE I						
VARIABLE	PATIENT'S	NORMAL	% CHANGE FROM			
	VALUE	VALUE	NORMAL			
P _a CO ₂	43	40	+ 7.5			
(mmHg)			HIGH			
P _a O ₂	96	96-100	0			
(mmHg)			NORMAL			
VC	6.7	5.9	+ 13.5			
(Liters)						
% FEV _{1sec}	63	>75	- 16			
			LOW			
pH (plasma)	7.34	7.4	LOW			
CL	0.7	0.2	+ 250			
(L/cm H ₂ O)			HIGH			

- 1. Why is Mr. Hackenkoff's C_{L} higher than normal?
 - A. *Alveolar interdependence has been compromised.
 - B. The presence of fibrous connective tissue in the alveoli has stiffened the lung.
 - C. There is excess surfactant present.
 - D. The mucus elevator in the trachea has increased its activity.
- 2. Plasma pH values are low compared to normal because:
 - A. O_2 is at the lower range of normal.
 - B. VC is higher than normal.
 - C. *CO₂ isn't being exhaled efficiently.

- 3. One reason that cancerous growths were detected in the pharynx and not the lungs was because mucus containing carcinogens from cigarette smoke particulates accumulated there due to the action of the tracheal mucus elevator.
 - A. *True
 - B. False
- 4. Based on the above clinical data, you would state that Mr. Hackenkoff would have trouble during:
 - A. a forced inhalation.
 - B. *a forced exhalation.
 - C. both forced inhalation and forced exhalation.
- 5. Based on the above clinical data, you would state that the barrel chest displayed by Mr. Hackenkoff:
 - A. Was the result of increased stiffness of the lungs.
 - B. Would hinder emptying of the alveoli.
 - C. Is a consequence of normal compliance.
 - D. *Is a partial compensation that increases the elastic recoil of the alveoli, making exhalation easier.
- 6. The signs and symptoms presented by Mr. Hackenkoff are in congruence with a diagnosis of:
 - A. *Emphysema
 - B. Pulmonary fibrosis
 - C. Partially collapsed lung.
 - D. Hyperventilation.

End of questions about the case

- 7. If a mucus plug blocks airflow to one portion of the lung:
 - A. The vasculature of the affected portion of the lung will dilate.
 - B. *The vasculature of the affected portion of the lung will constrict.
 - C. There will be no change in blood flow to the affected portion of the lung.

- 8. How would hyperventilation affect a patient's alveolar gas composition from normal values?
 - A. Increased P_AO_2 , No change in P_ACO_2
 - B. Increased P_AO₂, Increased P_ACO₂
 - C. *Increased P_AO₂, Decreased P_ACO₂
 - D. Decreased P_AO₂, Increased P_ACO₂
- 9. D_{LCO} (Lung diffusing capacity of carbon monoxide) is normally around 20-30 ml/minute per mmHg CO. Thickened alveolar gas exchange membranes would result in a(n):
 - A. Increased D_{LCO.}
 - B. *Decreased D_{LCO.}
 - C. No change in D_{LCO.}
- 10. All of the following are decreased in a patient (when compared to normal values matched for age, gender and body mass): VC, IRV, ERV and TV. This would be consistent with a diagnosis of:
 - A. An obstructive type of lung pathology.
 - B. *A restrictive type of lung pathology.

Use the data below to answer Questions 11 to 15 ONLY.

A patient presents with the data in Table II below:

VARIABLE	PATIENT'S VALUE	NORMAL VALUE	% CHANGE FROM NORMAL		
P _A CO ₂ (mm Hg)	37.2	40.0	- 7		
			LOW		
P _A O ₂ (mm Hg)	127.3	104	+ 22.4		
			HIGH		
рН	7.51	7.4	HIGH		
PULMONARY	58	96-100	- 40		
VENOUS PO ₂ (mm Hg)			LOW		
PULMONARY	37.2	40.0	- 7		
VENOUS PCO ₂ (mm			LOW		
Hg)					
RESPIRATORY RATE	24	14	+ 71		
(per minute)			HIGH		
% HEMOGLOBIN	90	96-98	- 8		
SATURATION			LOW		
HEMOGLOBIN (g/dL)	15.0	15.0	0		
-			NORMAL		

- 11. Is the patient hyperventilating or hypoventilating ?
 - A. *Hyperventilating.
 - B. Hypoventilating.
- 12. The pulmonary venous PCO_2 has come to equilibrium with the P_ACO_2 but the pulmonary venous PO_2 has not reached equilibrium with the P_AO_2 . Why not ?
 - A. O₂ has a less vigorous gas transport system across the alveolar membrane.
 - B. *The diffusion coefficient for O_2 is less than for CO_2 .
 - C. CO₂ can cross the alveolar membrane against its partial pressure gradient, while O₂ can only cross the alveolar membrane down its partial pressure gradient.
 - D. CO₂ is readily transported by hemoglobin, more so than O₂.
- 13. Has the work of breathing for this patient increased ?
 - A. *Yes.
 - B. No.
- 14. From the data presented, you would conclude that:
 - A. *The patient has a diffusion limited gas exchange system.
 - B. The patient has a perfusion limited gas exchange system.
- 15. Is the patient hypoxic?
 - A. *Yes.
 - B. No.



Questions 16 & 17 ONLY: Refer to Figure 1, below.

- 16. The shaded flow-volume loop shown above is indicative of a(n):
 - A. *Obstructive pathology.
 - B. Restrictive pathology.
 - C. An unusual pathology where dynamic compression only occurs during inspiration.
- 17. The expiratory flow rate of a normal person (dotted line) is independent of effort because:
 - A. The normal subject's airways are always maximally open during forced expiration.
 - B. *Of dynamic compression of the proximal airways.
 - C. Of dynamic expansion of the proximal airways.
 - D. Of sympathetic dilation of the bronchi & bronchioles.

End of questions about the case

- 18. Most of the CO₂ is transported by the blood in which form?
 - A. As dissolved CO₂.
 - B. Combined with hemoglobin (carbamino hemoglobin).
 - C. *As HCO_3^- .
 - D. All of the above 3 forms transport equal quantities of CO₂.

- 19. Which of the following conditions will increase the P₅₀ of hemoglobin ?
 - A. *The Bohr effect. (hemoglobin buffering H⁺)
 - B. The Hamburger shift. (CI entering the erythrocyte)
 - C. Decreased concentration of 2,3 DPG in the erythrocyte.
 - D. Increased pH of the plasma.
- 20. Which of these variables will be altered from normal if a patient's hemoglobin content is reduced (from 15 g/dL to 8 g/dL), but he is breathing normal air at sea level ?
 - A. PO₂ of the end pulmonary capillary blood.
 - B. PO₂ within the erythrocyte residing in the end pulmonary capillary blood.
 - C. *O₂ content of the blood in the end pulmonary capillary.
 - $\mathsf{D}. \qquad \mathsf{PO}_2 \text{ of the alveolus.}$
- 21. You overhear one of your colleagues state that: "The chemical reactions that resulted in transport of CO₂ in its various forms in the peripheral tissues are reversed in the lung." Your colleague:
 - A. *Is correct.
 - B. Is partially wrong because the $H_2CO_3 \rightarrow HCO_3^- + H_2O$ reaction is not reversed.
 - C. Is partially wrong because CI⁻ enters the erythrocyte in the lung.
 - D. Is totally wrong and needs to study more.
- 22. True or false. When you exercise at a moderate level, your P_aCO_2 will remain at 40 mm Hg.
 - A. *True
 - B. False
- 23. The plasma concentration of which one of the following gasses is the most important regulator of respiration ?
 - A. O₂
 - B. N₂
 - C. H₂O
 - D. *CO₂
 - E. CO
- 24. Some forms of sleep apnea involving weak tracheal structures are creating a(n):
 - A. *Obstructive type of pathology.
 - B. Restrictive type of pathology

- 25. In which portion of the normal, upright lung, is the \dot{V}/\dot{Q} ratio most closely matched to the normal 0.8 ?
 - A. Dependent portion (Base of lung)
 - B. *Middle
 - C. Independent portion (Apex of lung).
- 26. Which one of the following reasons correctly explains why one can faint during a prolonged bout of coughing, not caused by tracheal blockage?
 - A. Too much head shaking during the cough.
 - B. Air is forced out too rapidly.
 - C. *Venous return is lowered.
 - D. P_aCO_2 is 40 mm Hg.
- 27. The compliance loop for the normal lung breathing at eupneic, (resting) tidal volumes:
 - A. Is in the area where the most work of breathing occurs.
 - B. Is in a relatively low compliant area.
 - C. *Is in an area where the work of breathing is lowest.
 - D. Is in an area of above normal compliance.
- 28. A patient has undergone a general surgical procedure to correct a podiatric pathology. The patient was anesthetized with a gaseous anesthetic and his breathing was maintained with a respirator. The patient was hyperventilated during the procedure. When recovering from the anesthetic, there was a prolonged interval before he could breathe unassisted. Why ?
 - A. P_AO₂ was too high and depressed respiration control centers.
 - B. *P_ACO₂ was too low and depressed respiration control centers.
 - C. P_AH₂O was inadequate and the alveolar membrane became denatured.
 - D. Plasma pH was too low.
- 29. A different patient's central respiratory control systems are over anesthetized and cease functioning. The patient's P_aO₂ drops to 60 mm Hg, but she is still breathing. What will happen if you have her breathe just pure oxygen without any mechanical ventilation ?
 - A. *She will stop breathing because her formerly low P_aO₂ (the stimulus for peripheral chemoreceptors) has been raised above 60 mm Hg.
 - B. She will experience hyperpnea and her P_aO_2 will recover back to normal.
 - C. She will stop breathing because her P_aCO₂ will fall below 40 mm Hg.

- 30. Calculate the correct value of P_AO_2 , given the following values: $P_iO_2 = 150 \text{ mmHg}$, $P_ACO_2 = 43.2 \text{ mmHg}$. Hint: use the modified gas equation and assume normal air composition at sea level.
 - A. 104 mm Hg
 - B. 63 mm Hg
 - C. 150 mm Hg
 - D. *96 mm Hg