CLINIQUIZ

Pulse oximetry

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The word *monitor* originated from the Latin word "*monere*", meaning "to warn." The primary role of monitoring devices is to alert the physician of changes in patient's conditions and modify the therapeutic interventions based on the information gleaned from the monitors. Pulse oximetry, sometimes called the fifth vital sign, is a noninvasive method of measuring hemoglobin saturation (SpO_2) by using a light signal transmitted through tissue. A low SpO_2 can provide warning of hypoxemia before other warning signs such as cyanosis or a change in heart rate become clinically apparent. (Please choose one best answer)

Q 1. Pulse-oximeter works on which of the following principle?

a. Hagen Poiseuille's law
b. Paul Bert law
c. Poynting effect
d. Beer Lambert law

Q2. Which of the following represents the peak of the pulse oximeter wave on monitor?

a. Venous blood
b. Venous blood + Capillary Blood
c. Arterial blood + Venous blood + Capillary Blood + Intervening tissue
d. Capillary Blood + Intervening tissue

Q 3. The dicrotic notch in plethysmograph waveform descends to baseline during which of the following vessel wall condition?

a. Vasoconstriction
b. Vasodilation
c. Capillary shunting
d. Both A & B

Q 4. Which of the following statement regarding pulse oximeter is incorrect?

a. At the red wavelengths (650 to 750 nm), oxyhemoglobin absorbs more light than does reduced hemoglobin.
b. Reusable probes offer good shielding from ambient light compared to disposable probes
c. The LEDs provide monochromatic light that they emit a constant wavelength and never need recalibration
d. The probe placed on index finger can cause corneal abrasion.

Q 5. Pulse oximetry may provide accurate and reliable readings in which of the following clinical conditions?

a. Neonatal hyperoxia
b. Dysrhythmias
c. Cardiac arrest
d. Compartment syndrome

Q 6. Which of the following clinical condition is associated with a falsely elevated reading on pulse-oximetry?

a. Methemoglobinemia
b. Intravenous methylene blue dye injection
c. Carbon monoxide poisoning
d. Venous pulsation

Q 7. Ear probe can give erroneous reading than finger probe in which condition:

a. Mitral valve prolapsed
b. Mitral regurgitation
c. Tricuspid incompetence
d. Aortic incompetence

Q 8. Which among the following is a false statement regarding the oximeter standards?

a. There must be a means to limit the duration of continuous operation at temperatures above 41°C.
b. The accuracy must be stated over the range of 60% to 95% SpO2. If the manufacturer claims accuracy below 60%, the accuracy must be stated over the additional range.
c. There must be an indication when the SpO2 or pulse rate data is not current.
d. An indication of signal inadequacy must be provided if the SpO2 or pulse rate value displayed is potentially incorrect

Q 9. Which of the following clinical condition is associated with an oxygen saturation of approximately 85%?

a. Methemoglobinemia
b. Carboxyhemoglobinemia
c. Sulfhemoglobinemia
d. Sickle cell anemia

Q 10. Fractional oxygen saturation (% HbO_2) is the ratio of oxyhemoglobin to which of the following hemoglobin?

a. Methemoglobin
b. Carboxyhemoglobin
c. Deoxyhemoglobin
d. All of the above

Explanations

Ans. 1 (d): Hagen–Poiseuille law describes the pressure drop in gas in laminar flow flowing through a long cylindrical pipe of constant cross section and applies to the gas flow through flowmeters. Paul Bert effect describes CNS toxicity that occurs at oxygen pressures of > 3 ATA and has features like nausea, vomiting, rigidity, tremors and mentation changes. Poynting effect generally refers to the change in the vapor pressure of a liquid when a non-condensable gas is mixed with the vapor at saturated conditions and applies to mixture of O_2 and N_2O in a gas cylinder. Beer Lambert law states that absorption of light passing through a medium increase with the concentration of medium or substance (greater the number of molecules, greater the absorption) and the distance through which the light travels: greater the distance, more the number of molecules it encounters on the way, greater the absorption.

Ans. 2(c): Arterial blood is sampled in addition to all the other three structures during the peak of pulse wave in pulse oximetry. During the trough of pulse wave, the pulse oximeter LED's samples Venous blood + Capillary Blood + Intervening tissue. Therefore, pulse oximeter measures the O2 saturation of haemoglobin in arterial blood.

Ans. 3(b): The plethysmograph signal amplitude is directly proportional to the vascular distensibility over a wide range of cardiac output. The dicrotic notch in pulse oximeter waveform tends to descend towards baseline during increasing vasodilation and gets higher with vasoconstriction.

Ans. 4(a): Reduced hemoglobin absorbs more light at red wavelengths (650 to 750 nm) while oxyhemoglobin absorbs more light at infrared wavelengths (900 to 1000 nm). During awakening from anesthesia, corneal injury may occur if the patient rubs his eyes with the probe placed in index finger.

Ans. 5(b): Pulse oximetry is accurate in patients with dysrhythmias, provided that the plethysmogram has reasonable amplitude (i.e. the rhythm should generate a peripherally detectable pule). In neonatal hyperoxia, the pulse oximeter cannot evaluate the excess of oxygen concentrations ($\uparrow$ in PaO_2) in blood. Peripheral pulses are weak or absent in compartment syndrome and cardiac arrest.

Ans. 6(c): Carbon monoxide poisoning is associated with falsely elevated SpO_2 levels despite a decrease in tissue oxygenation. The rest of the conditions are associated with falsely low SpO_2 readings.

Ans. 7(c): The amplitude of plethysmography responds mainly to change in pulse pressure which would be reflected in venous circulation in the form of venous pulsations in tricuspid valve regurgitation. So pulse oximetery will show an erroneous reading in case of tricuspid incompetence.

Ans. 8(b): The accuracy of pulse oximeter is stated over the range of 70% to 100%. If the manufacturer claims accuracy below 65%, the accuracy must be stated over the additional range. Other standards related to pulse oximeter include:

If the manufacturer claims accuracy during motion or conditions of low perfusion, this and the test methods used to establish it must be disclosed in the instructions for use.

If the pulse oximeter is provided with any physiologic alarm, there must be an alarm for low SpO2 that is not less than 85% SpO2 in the manufacturer-configured alarm preset.

Ans.9(a): Cyanosis of blood, skin and mucous membranes can be caused by greater than 5 grams per cent of deoxyhemaglobinemia, or 1.5 grams per cent of methemaglobinemia, or 0.5 grams per cent of sulphemoglobinemia, requiring immediate medical attention.

Ans. 10(d): Fractional oxygen saturation (% HbO2) is the ratio of oxyhemoglobin to the sum of all functional hemoglobin species present, whether available for reversible binding to oxygen or not.

Reference

Dorsh & Dorsh. Understanding Anesthesia Equipment 5th Edition.