SNACC

SOCIETY FOR NEUROSCIENCE IN ANESTHESIOLOGY AND CRITICAL CARE

Neuro Quiz 25 - Monitoring

This quiz is being published on behalf of the Education Committee of the SNACC

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START

1. Which of the following monitor is **NOT** used to measure Oxygen

A. Paramagnetic analyzer
B. Galvanic cell analyzer
C. Polarographic sensor
D. Infrared gas analyzer
E. Clark electrode

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1. A. Paramagnetic analyzer

- Oxygen, because of its unpaired electron in the outer orbit, is paramagnetic or attracted towards a magnetic field
- This is the most common principle used to measure oxygen in the inspired and expired gases in the anesthesia machine
- Nitric oxide is also paramagnetic, while most other anesthetic gases are weakly attracted into a magnetic field. Nitrogen is diamagnetic or repelled from a magnetic field

1. B. Galvanic cell analyzer

- The Galvanic, *Hersch* or the 'Fuel' cell are similar to the polarographic sensor, but the electrodes are chosen to provide their own current
- The cathode is often gold or silver, and the anode is usually lead, with potassium hydroxide as the electrolyte solution
- $2Pb + 6OH^- = 2PbO_2H^- + 2H_2O + e^-$
- The flow of electrons is proportional to the concentration of oxygen present

1. C. Polarographic sensor

- The Polarographic (Clark) Oxygen electrode can measure partial pressure of oxygen in blood or a gas sample
- The Teflon membrane allows the oxygen tension in the blood to equilibrate with the electrolyte solution

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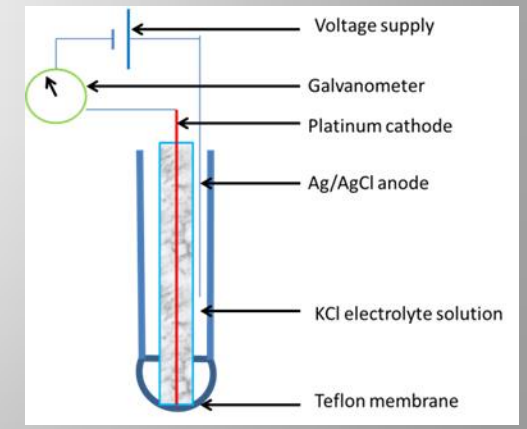

1. D. Infrared gas analyzer

- Molecules with two or more dissimilar atoms absorb infrared (IR) radiation and different molecules have distinct IR absorption spectra
- This technique is used to measure CO_2 and anesthetic gases
- Oxygen, nitrogen, helium, xenon, and argon do not absorb IR radiation and cannot be measured by this technique

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1. E. Clark electrode

- The Clark electrode is the same as Polarographic sensor
- It can measure partial pressure of oxygen in blood or a gas sample
- The Teflon membrane allows the oxygen tension in the blood to equilibrate with the electrolyte solution

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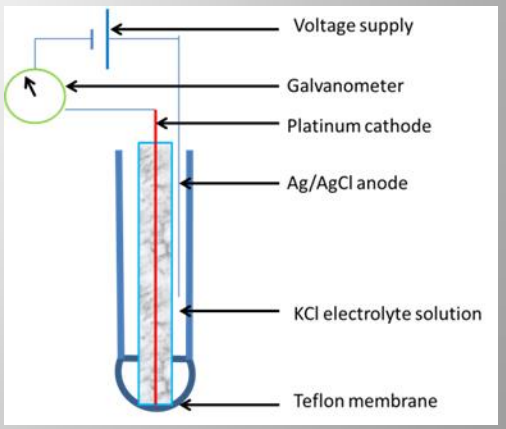
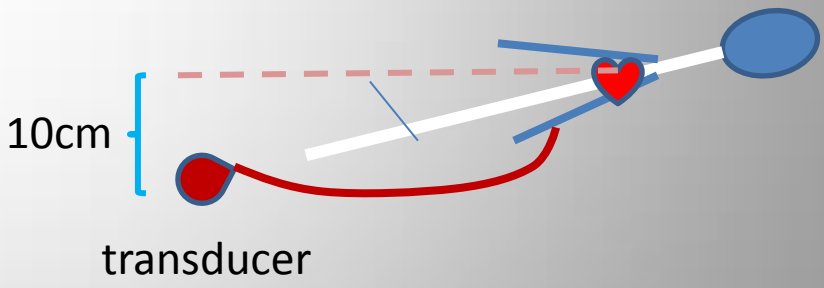


2. After induction of a 2y old for craniofacial advancement, a 22G was inserted into the left radial artery for pressure monitoring and the transducer was fixed at the foot end of the table and zeroed. During surgery, the table was placed in reverse Trendelenburg with the transducer 10cm below the heart level of the child. Which of the following is TRUE?

A. Recorded pressure will be 10mmHg higher than true pressure
B. Recorded pressure will be 10mmHg lower than true pressure
C. Recorded pressure will be 7.5mmHg higher than true pressure
D. Recorded pressure will be same as the true pressure
E. The transducer has to be re-zeroed



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2. A. Recorded pressure will be 10mmHg higher than true pressure

Since, the transducer is located 10 cm below the level of the patient's heart, there is a 10 cm H_2O fluid column from the level of the patient's heart to the transducer

This will cause the pressure reading from the transducer system to read approximately 7.5 mmHg higher (NOT 10mmHg) than the true arterial pressure

Sorry!
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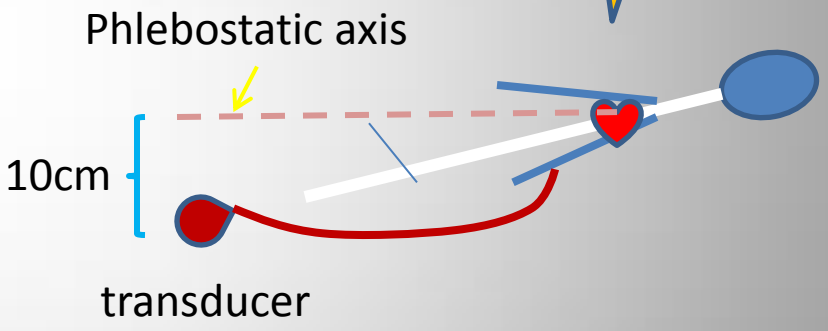

2. B. Recorded pressure will be 10mmHg lower than true pressure

Since, the transducer is located 10 cm below the level of the patient's heart, there is a 10 cm H_2O fluid column from the level of the patient's heart to the transducer

This will cause the pressure reading from the transducer system to read approximately 7.5 mmHg higher (NOT '10mmHg & lower') than the true arterial pressure

Sorry!
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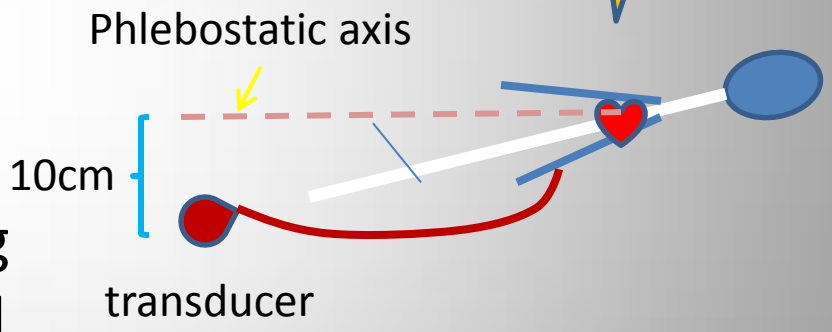
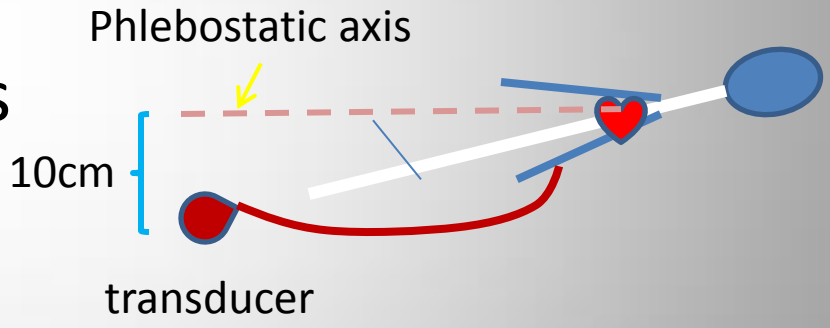


2. C. Recorded pressure will be 7.5mmHg higher than true pressure

Since, the transducer is located 10 cm below the level of the patient's heart, there is a 10 cm H_2O fluid column from the level of the patient's heart to the transducer

This will cause the pressure reading from the transducer system to read approximately 7.5 mmHg higher than the true arterial pressure



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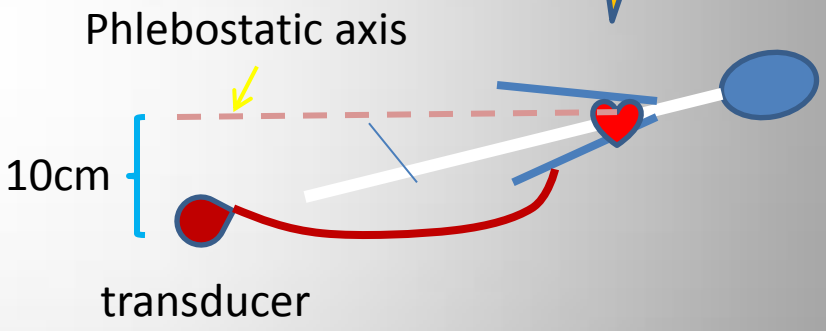
2. D. Recorded pressure will be same as the true pressure

Since, the transducer is located 10 cm below the level of the patient's heart, there is a 10 cm H_2O fluid column from the level of the patient's heart to the transducer

This will cause the pressure reading from the transducer system to read approximately 7.5 mmHg higher (NOT same) than the true arterial pressure

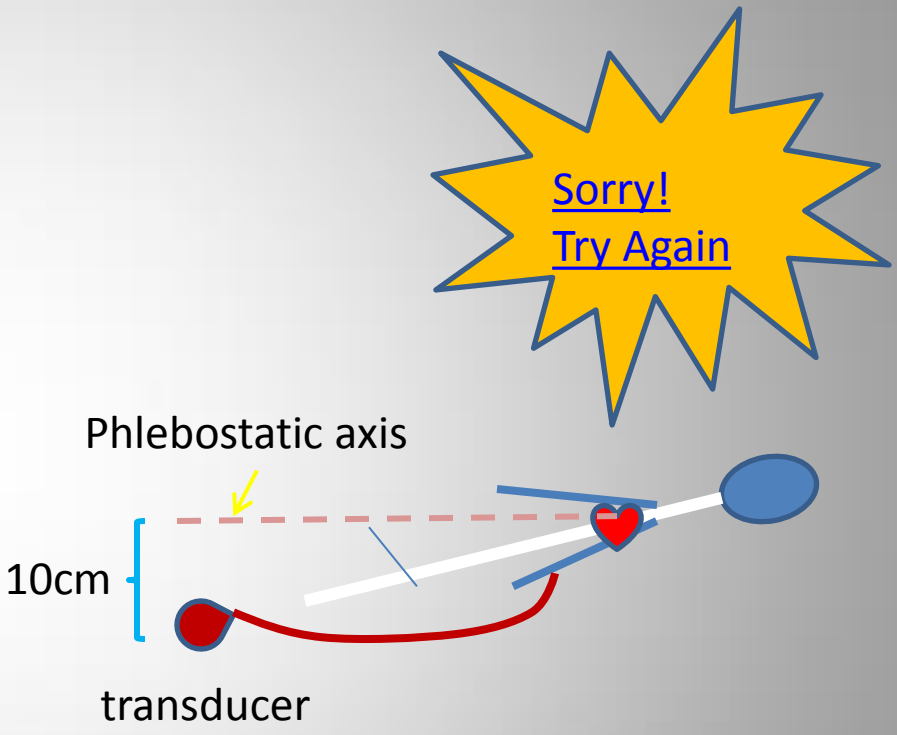
Sorry!
Try Again



2. E. The transducer has to be re-zeroed

The transducer is zeroed to the atmospheric pressure and since it was just done, there is no need to re-zero it

However, to get the correct pressure reading, the transducer can be raised to the Phlebostatic axis.



In a sitting position if the transducer is placed at the level of the tragus to measure the pressure at the level of the circle of Willis, the measured pressure will be 15 mmHg lower (~20cm higher) than the actual pressure

3. Which of the following monitors is the LEAST sensitive to detect Venous Air Embolism

A. Trans-Esophageal Echocardiography
B. Doppler sensor
C. Capnography
D. Pulmonary artery pressure
E. ECG changes

Next Question

3. A. Trans-Esophageal Echocardiography

- Trans-Esophageal Echocardiography (TEE) is the most sensitive monitor to detect venous air embolism (VAE)
- It can also identify right to left shunting of air in the presence of a patent *foramen ovale*
- However, its safety with prolonged use, especially with neck flexion is not well established

3. B. Doppler sensor

- Although, the standard of care to detect VAE is a precordial Doppler probe, placed over left or right parasternal, between 2nd and 3rd ribs, it is less sensitive than the TEE
- An audible, continuous ‘mill-wheel’ murmur is indicative of VAE
- It can detect VAE before any physical signs are evident

3. C. Capnography

- Although, ET CO_2 monitoring is part of standard of care, it is not the most sensitive to detect VAE, nor is it specific
- Presence of VAE causes regional blockade of pulmonary circulation leading to an increase in alveolar dead-space resulting in decrease in $ETCO_2$ and an increased 'arterial-ET CO_2' gradient
- A sudden rise in ET Nitrogen is also a sign of air embolism, but is usually short-lasting but can differentiate between air and thrombo- embolism

3. D. Pulmonary Artery Pressure

- A rise in pulmonary artery pressure will occur with significant venous air embolism and its sensitivity matches changes in $ETCO_2$
- These are the earliest, apparent physiological changes

3. E. ECG changes

- Significant VAE is manifest as RV strain pattern and ST depression on the ECG and they manifest along with hemodynamic instability
- VAE can occur during posterior fossa surgery (sitting position), cervical laminectomy, craniosynostosis procedure, cesarean section during uterine exteriorization

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4. During an intracranial surgery, in response to a sudden hemorrhage, the anesthesiologist increased the FIO_2 from 0.4 to 0.7. It was noted that the $ETCO_2$ dropped from 38 to 29 mmHg, while the $PaCO_2$ on the arterial blood was 40 mmHg. The likely cause for this increased $PaCO_2$-$ETCO_2$ gradient could be any of the following, EXCEPT:

1. Venous Air Embolism
2. Hypotension
3. Low cardiac output
4. Increased FIO_2
5. Hyperventilation

Next Question

4. A. Venous Air Embolism

- An (arterial-ET)PCO_2 is an index of alveolar dead space (normal value - 2-5 mm Hg)
- Common cause for intra-operative rise in alveolar dead space are reduced pulmonary blood flow
  - Pulmonary embolism (air, thrombus)
  - Hypotension
  - Low cardiac output

4. B. Hypotension

- An (arterial-ET)PCO_2 is an index of alveolar dead space (normal value - 2-5 mm Hg)
- Common cause for intra-operative rise in alveolar dead space are reduced pulmonary blood flow
  - Pulmonary embolism (air, thrombus)
  - Hypotension
  - Low cardiac output

4. C. Low cardiac output

- An (arterial-ET)PCO_2 is an index of alveolar dead space (normal value - 2-5 mm Hg)
- Common cause for intra-operative rise in alveolar dead space are reduced pulmonary blood flow
  - Pulmonary embolism (air, thrombus)
  - Hypotension
  - Low cardiac output

4. D. Increased FIO_2

- An (arterial-ET)PCO2 is an index of alveolar dead space (normal value - 2-5 mm Hg)
- High FIO_2 preferentially vasodilates well perfused alveoli, resulting in the redistribution of blood flow away from poorly perfused alveoli causing increased alveolar dead space
- BJA 2011; 107: 631

4. E. Hyperventilation

- Hyperventilation can reduce $ETCO_2$ but will also reduce the arterial PCO_2, thus maintaining the arterial-ET CO_2 gradient
- In the given scenario, an increased (a-ET) CO_2 can result from any of the other options

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5. Which of the following statements regarding intra-op evoked potential (EP) monitoring is TRUE?

A. Equipotent doses of Inhalational and intravenous anesthetics suppress EP equally
B. Brainstem Auditory EP (BAEP) are very sensitive to inhalational anesthetics
C. If motor evoked potentials are planned, muscle relaxants should not be used for intubation
D. Opioids and benzodiazepine have negligible effects on EP recordings
E. If intraoperative motor EP is planned, up to 50% nitrous oxide is acceptable

5. A. Equipotent doses of Inhalational and intravenous anesthetics suppress EP equally

- Inhalational anesthetic agents have more depressant effects on EP compared to IV agents and addition of nitrous oxide makes it worse
- MEP are exquisitely sensitive to inhalational agents and are best avoided or should be <0.5MAC, if it is used

5. B. Brainstem Auditory EP (BAEP) are very sensitive to inhalational anesthetics

- While short latency brainstem and spinal EP are resistant to the effects of anesthetic long-latency, cortical EP are sensitive to anesthetic agents
- BAEP are not sensitive to anesthetics and can be monitored under anesthesia

5. C. If motor evoked potentials are planned, muscle relaxants should not be used for intubation

- Although, monitoring of MEP precludes the use of muscle relaxants, its use for endotracheal intubation is not contraindicated if its effect wears off before the surgery and monitoring begins
- MEP are exquisitely sensitive to inhalational agents and are best avoided or should be <0.5MAC, if it is used
- TIVA is the preferred technique for MEP

5. D. Opioids and benzodiazepine have negligible effects on EP recordings

- Opioids and benzodiazepines have negligible effects on EP monitoring
- TIVA
  - Dexmedetomidine (0.2-0.5mcg/kg/h)
  - Remifentanil (0.05-0.3mcg/kg/m)
  - Propofol (25-150mcg/kg/m)
- Ketamine and Etomidate does not affect EP monitoring

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References

5. E. If intraoperative motor EP is planned, up to 50% nitrous oxide is acceptable

- Inhalational agents have more depressant effects on EP compare to IV agents and addition of nitrous oxide makes it worse

References

- Langton JA, Hutton A. Respiratory gas analysis. *CEACCP* 2009; 9: 19-23
- Miller, RD et al. Miller's Anesthesia, 7th ed, Churchill Livingstone: Chapter 63
- Yamauchi, *et al*. Dependence of the gradient between arterial and end-tidal PCO2 on the fraction of inspired oxygen. *BJA* 2011; 107 : 631

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