Neuro Quiz 49: Monitoring the Brain

START

THIS QUIZ IS BEING PUBLISHED ON BEHALF OF THE EDUCATION COMMITTEE OF THE SNACC

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1. Which of the following statements about Intra-Cranial Pressure (ICP) monitoring is **TRUE**?

A. The transducer of the intra-parenchymal pressure monitor is placed at the level of the tragus

B. The intra-ventricular pressure monitor does not provide a global measurement of ICP

C. ICP- guided therapy improves outcomes in patients with traumatic brain injury

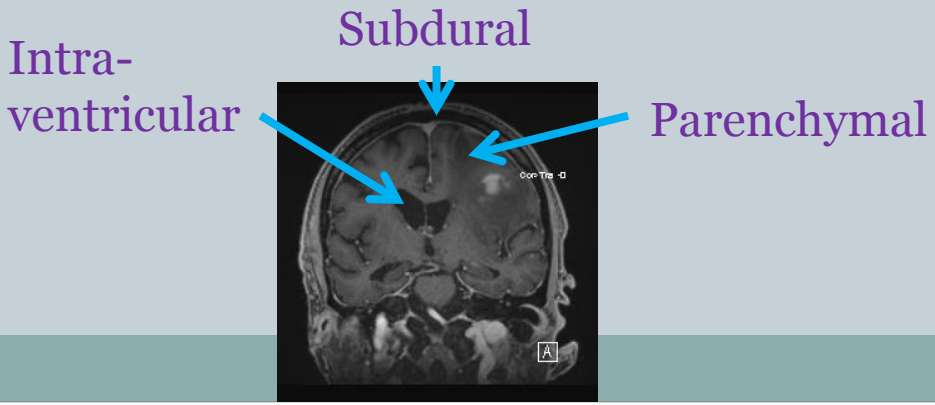
D. ICP monitoring is indicated in brain injured patients with GCS ≤8 even if the CT scan is normal

Next Question

1A. The transducer of the intra-parenchymal pressure monitor is placed at the level of the tragus

Try Again

- Intra-parenchymal ICP monitors have micro-transducers located at the tip of the catheters and their position cannot be changed.
- The miniature transducer technology varies with different manufacturers, e.g. Codman has a semiconductor strain gauge attached to a thin diaphragm. Any change in ICP distorts the membrane and changes the resistance of the strain gauge which is measured by a Wheatstone bridge and displayed as ICP
- These transducers are zeroed before insertion and cannot be recalibrated *unlike* the Intra-ventricular monitors

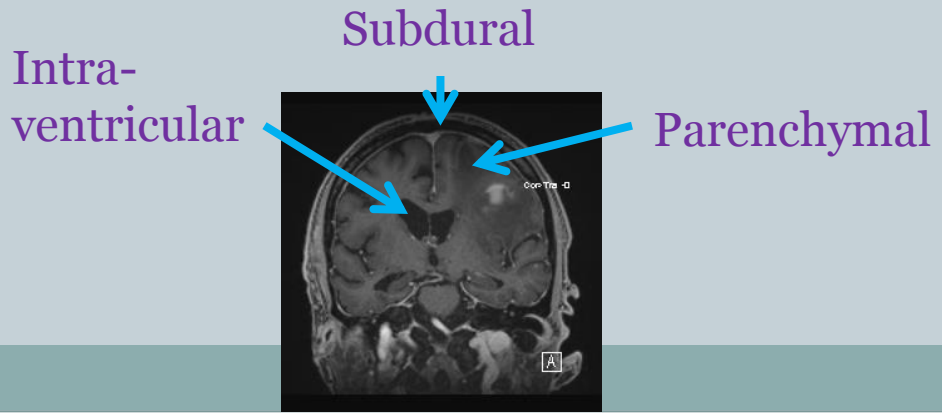


Next Question

1B. The intra-ventricular pressure monitor does not provide a global measurement of ICP

Try Again

- The intra-ventricular catheter is usually inserted into the lateral ventricles and it measures the global ICP
- The transducer should be kept at the level to the tragus
- When recording the cerebral perfusion pressure (CPP), the transducer measuring the arterial pressure should also be placed at the level of the tragus



Next Question

1C. ICP- guided therapy improves outcomes in patients with traumatic brain injury

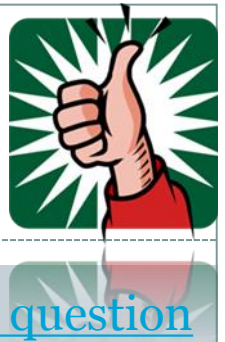
Try Again

- Although, ICP monitoring is the standard of care for all patients with severe brain injury, there is no Class I evidence suggesting that ICP-guided therapy improves outcomes in such patients

Global Neurotrauma Research Group. A trial of intracranial-pressure monitoring in traumatic brain injury. N Engl J Med 2012;367:2471-81.

Next Question

1D. ICP monitoring is indicated in brain injured patients with GCS ≤8 even if the CT scan is normal



Back to question

- This statement is correct
- ICP monitoring allows early detection of an expanding lesion and the CPP
- Cerebrovascular Pressure reactivity (PRx) index is a correlation of consecutive values of ICP and arterial pressure
  - A positive PRx suggests impaired autoregulation
  - A negative value reflects normal autoregulation
  - PRx can be used to estimate optimal CPP levels for individual patients

Next Question

2. Which of the statements about Intra-cranial pressure (ICP) monitoring is **TRUE**?

A. Lundberg type C wave indicates a poor prognosis in a patient with brain injury
B. The normal ICP in a 6 month old child is 10 mmHg
C. The normal ICP tracing is pulsatile
D. To calculate the cerebral perfusion pressure, the transducers measuring the MAP and the ICP should be zeroed at the level of the patient's heart

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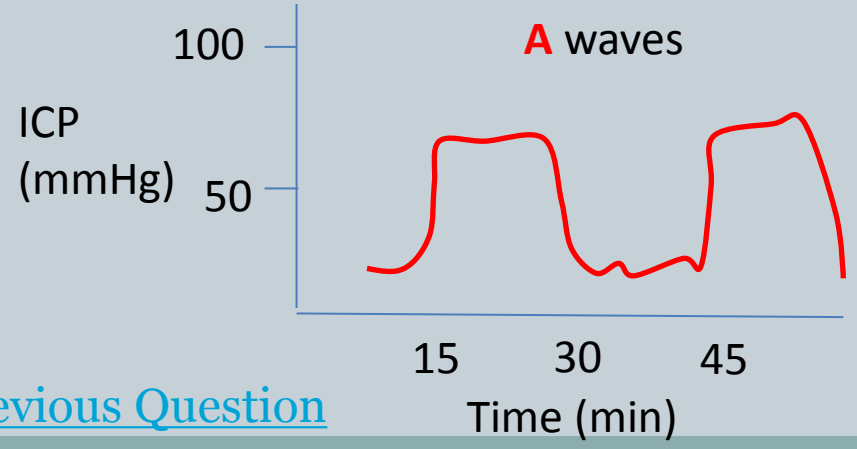
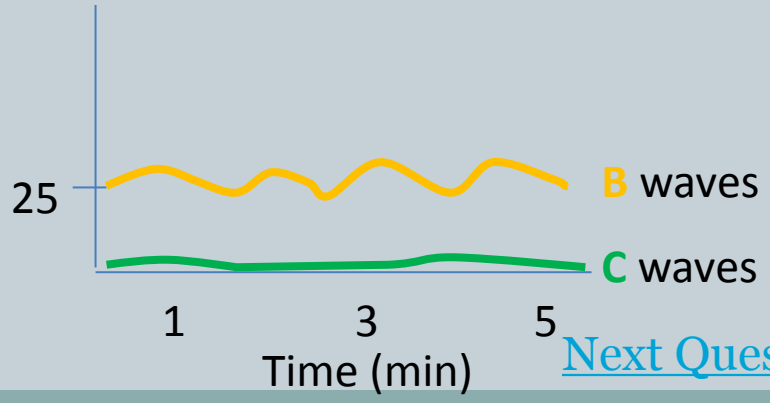
2A. Lundberg type C wave indicates a poor prognosis in a patient with brain injury

Try Again

Lundberg	Features	Clinical
A	Plateau shaped; 50-100 mmHg; 5-20min	Pathological, Very high brain impedance
B	Rhythmic oscillations; <50 mmHg; 1-2 min	High brain impedance
C	Rhythmic oscillations; <20 mmHg; 4-8min	Normal, synchronous with arterial pulsations





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2B. The normal ICP in a 6 month old child is 10 mmHg

Try Again

- This is incorrect
- The normal ICP is 3-4 mmHg up to 1 year of age and 10-15 mmHg in adults

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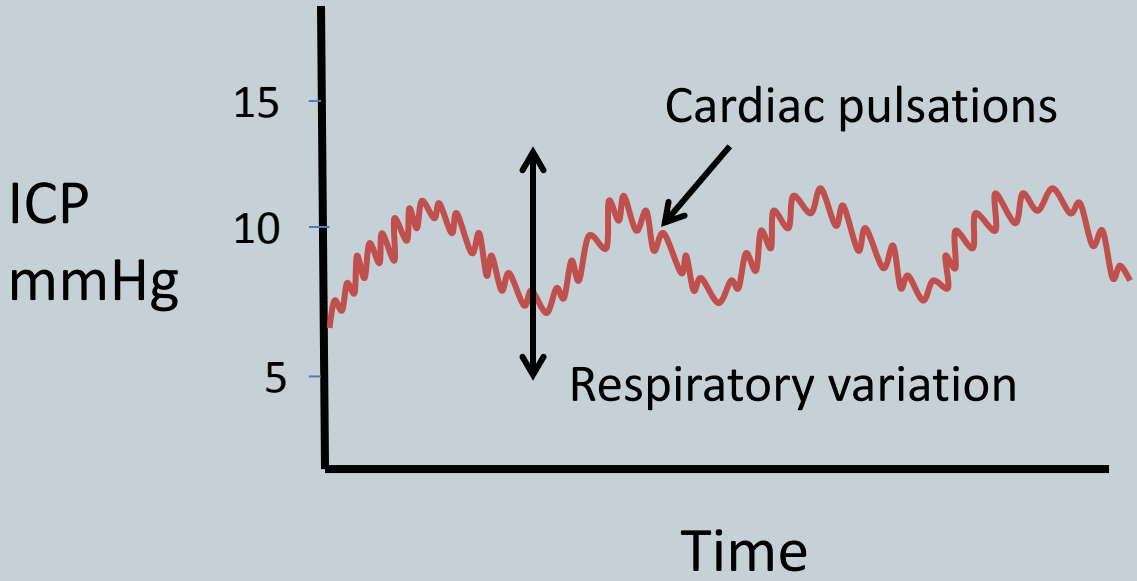
2C. The normal ICP tracing is pulsatile

Back to question

- Dynamic tracing of the ICP reflects the cardiac pulsations and the respiratory variations



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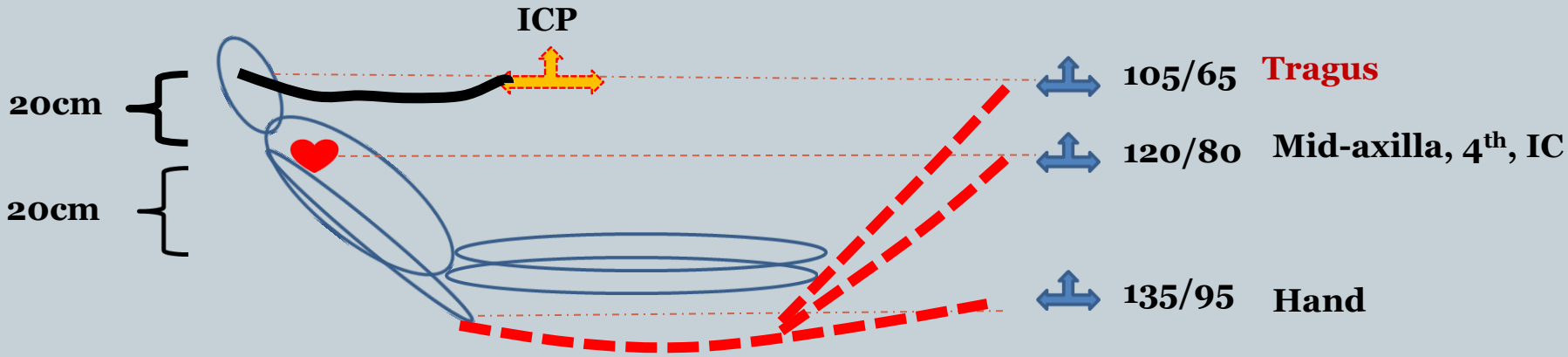
Next Question

2D. To calculate the cerebral perfusion pressure, the transducers measuring the MAP and the ICP should be zeroed at the level of the patient's heart

Try Again

- This is incorrect
- The transducers measuring the arterial pressure and the intraventricular ICP monitor should be at the level of the Circle of Willis, which corresponds to the tragus.



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3. Which of the following statements about measuring Cerebral Oxygenation is **TRUE**?

A. Near Infrared spectroscopy gives a good assessment of global cerebral oxygenation

B. The catheter tip of the Jugular venous oxygen saturation (Sj_vO_2) monitor should be at the level of C1/C2 spine

C. Normal brain tissue oxygen pressure $P_{br}O_2$ is <15mmHg

D. Brain tissue oxygen is measured by aspirating tissue fluid and analyzing it in a standard lab

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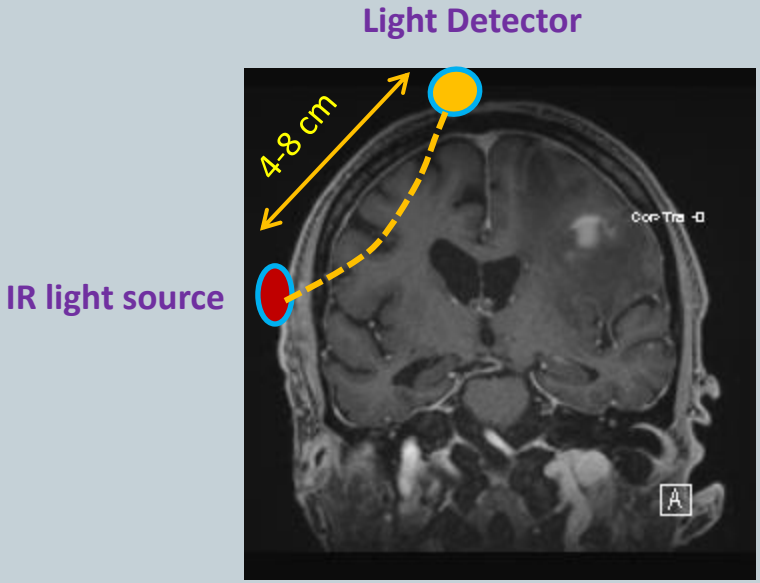
3A. Near Infrared spectroscopy gives a good assessment of global cerebral oxygenation

- This is incorrect as the NIRS is a non-invasive method to measure regional cerebral oxygenation

Try Again

- Infrared light (700-1000nm) is able to penetrate skin, bone and brain tissue and is absorbed by HbO_2 & Hb



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3B. The catheter tip of the Jugular venous oxygen saturation (SjvO2) monitor should be at the level of C1/C2 spine

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- The SjvO2 catheter is inserted into the internal jugular and passed cephalad to reach the jugular bulb and confirmed with X-ray

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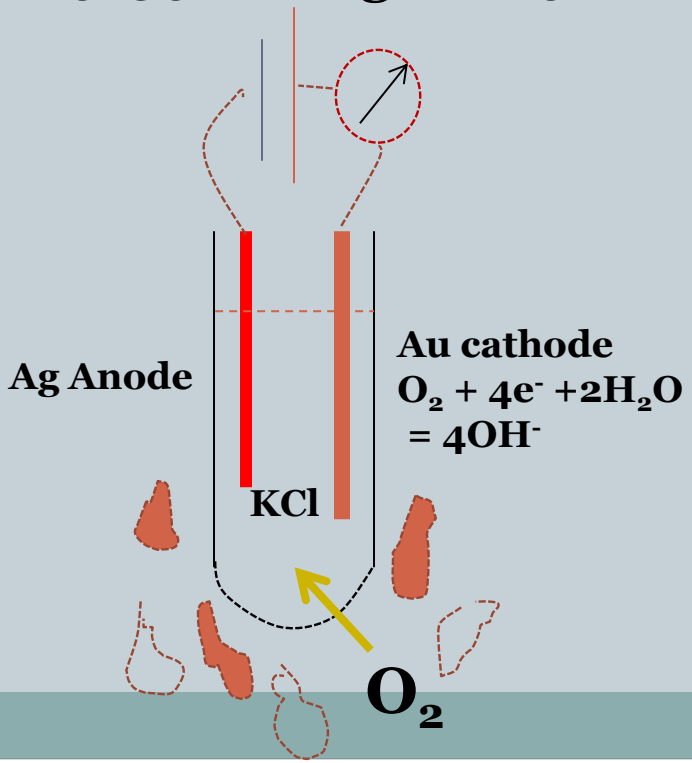
3C. Normal brain tissue oxygen pressure is <15 mmHg

Try Again

- Micro-catheters with a Polarographic electrode incorporated into its tip are placed into the brain tissue to measure $P_{br}O_2$
- Normal $P_{br}O_2$ is 25-35mmHg & <15 mmHg suggests local ischemia



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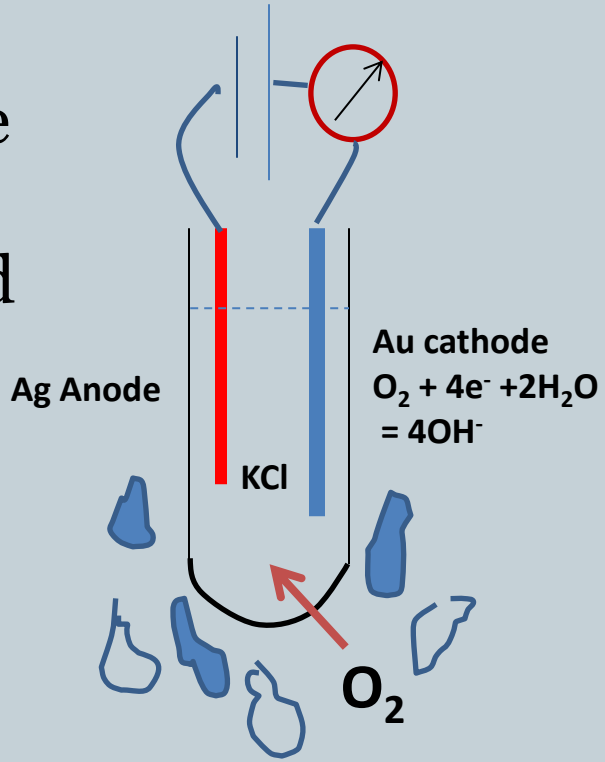
3D. Brain tissue oxygen is measured by aspirating tissue fluid and analyzed in a standard lab

Try Again

- This is incorrect
- Micro-catheters with a Polarographic electrode incorporated into its tip are placed into the brain tissue to measure $P_{br}O_2$ directly
- pH electrodes can also be incorporated to measure pH and PCO_2 levels
- Normal values
  - $P_{br}O_2$ – 25-35 mmHg
  - $P_{br}CO_2$ – 40-70 mmHg
  - pH – 7.05-7.25



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4. Which of the following statements about monitoring Cerebral Blood Flow (CBF) is **FALSE**?

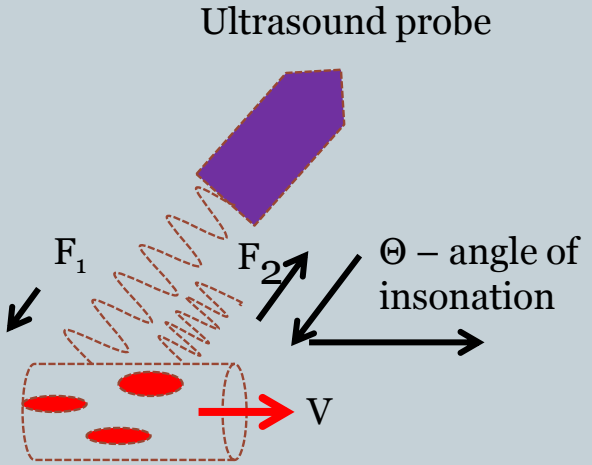
A. Transcranial Doppler (TCD) study is reliable for monitoring vasospasm after SAH
B. TCD can be used to estimate the ICP by measuring the pulsatility index
C. Xenon-enhanced CT scan can be used to quantify CBF
D. Measuring CBF by CT perfusion scan is time consuming and clinically unreliable

Previous Question Next Question

4A. Transcranial Doppler (TCD) study is reliable for monitoring vasospasm after subarachnoid hemorrhage

Try Again

- This is a correct statement
- A perceived change in frequency when a sound wave is reflected off a moving object is Doppler Effect, and the change depends on the velocity of the moving object
- TCD is used to monitor vasospasm after SAH. A flow velocity in the MCA of >120 cm/s with a Lindegaard index of 3-6 is highly suggestive of vasospasm
- $Lindegaard\ Index = \frac{FV\ in\ MCA}{FV\ in\ Int\ Carotid}$



$$F_2 - F_1 = \frac{2F_1 V\ Cos\theta}{speed\ of\ sound}$$

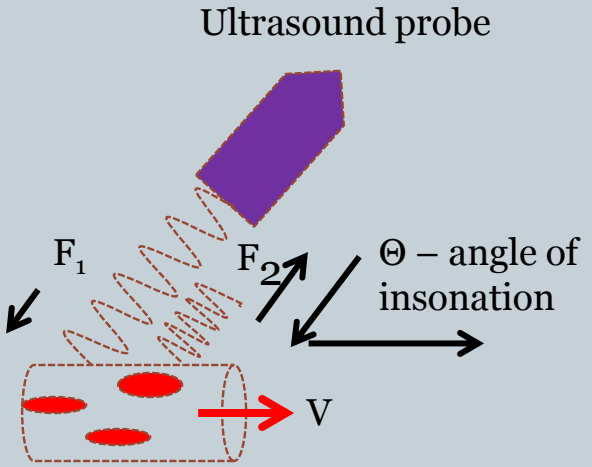
Previous Question

Next Question

4B. TCD can be used to estimate the ICP by measuring the pulsatility index

Try Again

- $Pulsatility\ Index\ (PI) = \frac{Systolic\ FV - Diastolic\ FV}{Mean\ Flow\ velocity\ (FV)}$
- There is a strong correlation between ICP & PI
- Surg Neurol. 2004;62:45-51
- TCD can also detect micro-emboli and intraoperative cerebral perfusion during carotid surgery



$$F_2 - F_1 = \frac{2F_1 V\ Cos\theta}{speed\ of\ sound}$$

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4C. Xenon-enhanced CT scan can be used to quantify CBF

Try Again

- Xenon, being highly lipid soluble, can readily cross the blood-brain barrier and enhance the CT scans
- After a baseline CT scan the patient breathes xenon till it equilibrates
- The xenon is then discontinued and serial scans are performed to analyze the washout of xenon which is used to quantify the CBF

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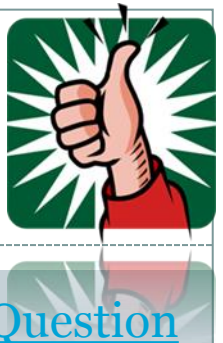
4D. Measuring CBF by CT perfusion scan is time consuming and clinically unreliable



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- The second part of this statement is incorrect
- CBF can be measured accurately by CT perfusion, especially in acute stroke and SAH to delineate the area of potentially reversible ischemic penumbra from the infarcted area
- After administering a contrast dye scan slices at the level of the basal ganglia are taken to visualize the anterior, middle and posterior cerebral artery territories
- These methods are expensive, time-consuming and put the patient at risk of contrast agents related problems and also transportation to a remote facility

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5. Which of the following statements regarding monitoring the brain metabolism using the Cerebral Micro-dialysis is **TRUE**?

A. The brain tissue fluid is directly aspirated and the concentration of the metabolites measured
B. It is used as a test to confirm secondary brain injury after it is evident on other monitors
C. A high Lactate-Pyruvate ratio indicates cerebral ischemia
D. A rise in glucose in micro-dialysate 2-3 days after ~~a~~ brain injury indicates cell death

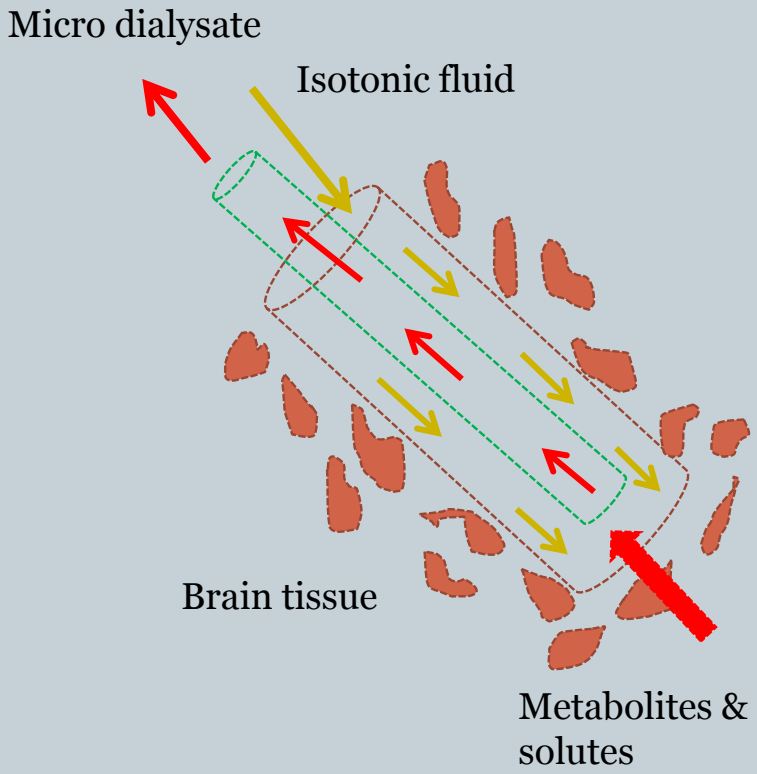
Previous Question

References

5A. The brain tissue fluid is directly aspirated and the concentration of the metabolites measured

Try Again

- This is incorrect
- The micro-dialysis probe is essentially a coaxial catheter with a semipermeable dialysis membrane lining its tip
- Through the outer channel, fluid, isotonic to the brain extracellular fluid, is pumped at 0.3µL/min and aspirated back through the inner tube
- The dialysis membrane at the tip allows diffusion of water and solutes from the interstitial fluid into the catheter along its concentration gradient



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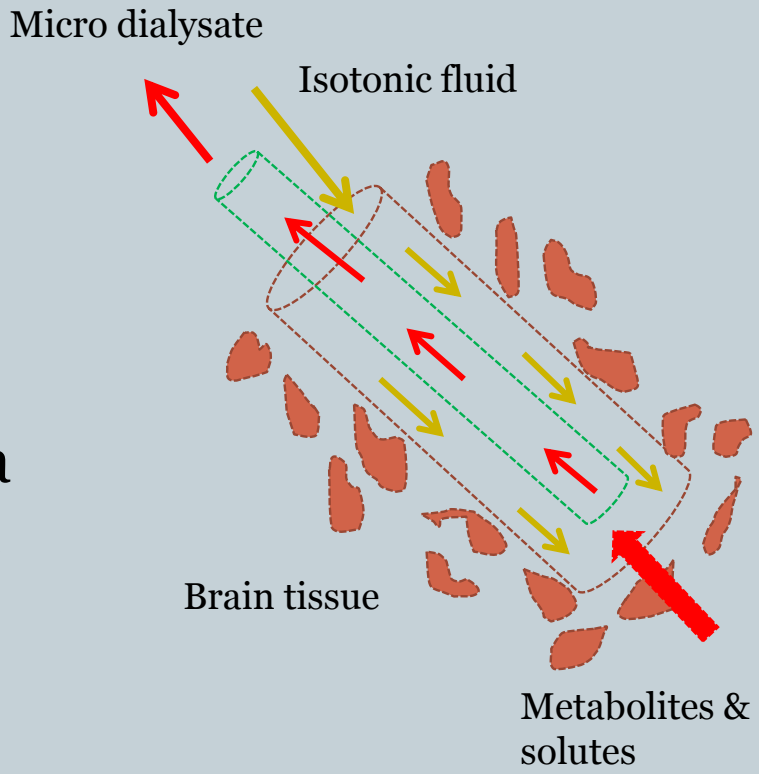
References

5B. It is used as a test to confirm secondary brain injury after it is evident on other monitors

Try Again

- Cerebral micro-dialysis can detect changes in the metabolism at the cellular level before changes are detected in other monitors for brain physiology
- The micro-dialysis probe is essentially a coaxial catheter with a semipermeable dialysis membrane lining its tip that allows diffusion of cellular metabolites



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References

5C. A high Lactate-Pyruvate ratio indicates cerebral ischemia

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Metabolites and solutes measured by cerebral micro-dialysis

- Energy related metabolites – glucose, lactate, pyruvate
  - **Markers of secondary brain ischemia**
    - Glucose <1.5 mmol/L
    - Raised lactate to pyruvate ratio (>20)
- Neurotransmitters – glutamate, aspartate
  - High levels are seen in secondary cerebral ischemia.
- Cellular degradation markers – glycerol, potassium
  - Glycerol is produced by degradation of the phospholipids from dead cells. High levels have been measured after severe TBI and also secondary ischemia.
- Exogenous – drugs

Previous Question

References

5D. A rise in glucose in the micro-dialysate 2-3 days after ~~a~~ brain injury indicates cell death

Try Again

This is incorrect.

A rise in **glycerol** indicates cell death

Glucose level **decreases** with brain ischemia

Metabolites and solutes measured by cerebral micro-dialysis

- Energy related metabolites – glucose, lactate, pyruvate
  - Markers of secondary brain ischemia
    - Glucose <1.5 mmol/L
    - Raised lactate to pyruvate ratio (>20)
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THANK YOU