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This quiz is being published on behalf of the Education Committee of the SNACC.
The authors have no financial interests to declare in this presentation.

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1. A 4 month old child is undergoing a craniectomy for craniosynostosis under general anesthesia. Suddenly the systolic BP drops from 75 mmHg to 30 mmHg and the EtCO2 decreases from 35 to 6 mmHg. Which of the following maneuvers is LEAST likely to have a beneficial effect? 

Please click on answer choices

A. Administration of a fluid bolus
B. Administration of a vasopressor
C. Application of PEEP
D. Aspiration of the central line
E. Flooding of the wound with saline

Go to Q 2
Children undergoing craniosynostosis repair are subject to significant hemodynamic changes, including venous air embolism and significant blood loss. Administration of fluid bolus would be very helpful in correcting a low blood pressure in this situation.

The goal of hydration is reducing the gradient between the right atrium and the entraining vessel.
B. ADMINISTRATION OF A VASOPRESSOR

Hemodynamic support often includes vasopressor support. Due to the obstruction being mainly to the right side of the heart by the entrained air, the increase in right ventricular afterload subsequently causes left ventricular failure. Hence, right ventricular support should be kept in mind. Therefore, dopamine, dobutamine and epinephrine, are effective in supporting blood pressure and restoring cerebral blood flow, even in very low birth weight infants.

M.J. Munro, A.M. Walker, C.P. Barfield
Hypotensive extremely low birth weight infants have reduced cerebral blood flow
Pediatrics, 114 (2004), pp. 1591–1596
Mirski et al, Anesthesiology 2007;106; 164-77

Incorrect

Try again!!
C. APPLICATION OF PEEP-
The application of positive end-expiratory pressure increases central venous pressure but also decreases cardiac filling pressure, cardiac output, and blood pressure—unlikely to be beneficial. It may increase the chance of paradoxical air embolism and further cardiovascular compromise.

The following are the likely steps to be taken in suspected venous air embolism

- Inform surgeon immediately.
- Discontinue N₂O if being administered, increase O₂ flows.
- Have the surgeon flood the surgical field with fluids.
- Change the patient’s position to lower the head to the heart level
- Aspirate the right atrial catheter.
- Provide cardiovascular support.
- Jugular venous compression although a recommendation could dislodge atherosclerotic plaques, cause venous engorgement and brain edema and so should be used with caution.

Ref: Cottrell and Young’s textbook of neuroanesthesia: Chapter 12
D. ASPIRATION OF THE CENTRAL LINE

- Aspiration of air from a central venous catheter is rarely successful unless massive amounts have been entrained. However, aspiration of air through a central venous catheter may be attempted, if one is in place.

Smiths textbook of pediatric anesthesia: Monica S. Vavilala and Sulpicio G. Soriano. Ch 22, page 729

Try again!!
Attempts should immediately be made to identify and occlude the site of air entry, either by flooding the operative field with saline when appropriate (such as during a posterior fossa craniotomy) or by applying bone wax to bone edges.
2. Which of the interventions to be carried out in the emergency department is most likely to reduce intracranial pressure rapidly in traumatic brain injury?

Please click on answer choices

A. **Intubate and hyperventilate**
B. **Intravenous administration of opioid**
C. **Intravenous administration of corticosteroid**
D. **IV administration of nitroprusside**
E. **IV administration of furosemide**

[go to Q 3]
Upon arrival to the Emergency department, the major priorities are ensuring cerebral perfusion and preventing brain herniation. Hyperventilation to a PaCO$_2$ of 30–35 mmHg is likely to be beneficial for acute sharp increases in intracranial pressure or signs of impending herniation. Manual bag mask ventilation could be followed by mechanical ventilation depending on the situation. Other tier 1 treatments include: Mannitol or Hypertonic Saline (if systolic blood pressure is < 90mmHg).

Brain Trauma Foundation: Guidelines for the Management of Severe Traumatic Brain Injury 3rd Ed (AANS, CNS) 2007
B. ADMINISTRATION OF IV OPIOID

Administration of opioids would not help with intracranial pressure reduction. Although opioids are used to treat pain in trauma patients, negative side effects like drop in mean arterial pressure and decrease in cerebral perfusion pressure should be watched for.
C. ADMINISTRATION OF CORTICOSTEROIDS

The use of steroids is not recommended for improving outcome or reducing the intracranial pressure in traumatic brain injury. According to the brain trauma foundation guidelines, there is strong evidence that steroids are deleterious: thus their use is not recommended.

The CRASH (Corticosteroid Randomization After Severe Head Injury) trial in 2004 reported the results of an international randomized control trial in which 10,008 patients were randomized to receive methylprednisolone or placebo. The study was halted after about 5 years when interim analysis showed a deleterious effect of methylprednisolone. Specifically, the two week mortality in the steroid group was 21% versus 18% in the controls, with a 1.18 relative risk of death in the steroid group (95% CI 1.09-1.27, p=0.0001)
D. ADMINISTRATION OF NITROPRUSSIDE

Sodium nitroprusside should not be used in patients with raised intracranial pressure due to its ability to dilate cerebral blood vessels resulting in a rise in intracranial pressure and a decrease in cerebral perfusion pressure consequent to lowering of the mean arterial pressure.

Cottrell J.E: J Neurosurg. 1978 Mar;48(3); 329-31
E. ADMINISTRATION OF FUROSEMIDE

- Although furosemide reduces CSF production and consequently can lower the intracranial pressure, this is not the standard of care in the above situation. However, mannitol may be used for osmotic diuresis and decreasing the raised ICP.

Incorrect

Try again!!
3. WHICH OF THE FOLLOWING STATEMENTS CONCERNING AUTONOMIC HYPERREFLEXIA IS TRUE??

Please click on answer choices

A. **It occurs within 24 hours after injury**
B. **It occurs with lesions below T 10**
C. **It occurs with reflex increase in parasympathetic outflow**
D. **It is characterized by paroxysmal hypotension and tachycardia**
E. **It is prevented by blocking afferent visceral pathways**

go to Q 4
A. IT OCCURS WITHIN 24 HOURS AFTER INJURY

Autonomic hyperreflexia is a potentially life threatening condition characterized by a sudden uncontrolled sympathetic response secondary to noxious stimuli. It occurs usually in the first six months after injury. It does not occur within 24 hours after injury.
This choice is incorrect. The incidence is reported to be between 48% and 98% in patients with quadriplegia and high paraplegia (lesion above T6).

C. IT OCCURS WITH REFLEX INCREASE IN PARASYMPATHETIC OUTFLOW

Autonomic hyperreflexia is triggered by a noxious stimulus below the level of the lesion, which then activates unopposed sympathetic activity.

Try again!!
D. IT IS CHARACTERIZED BY PAROXYSMAL HYPOTENSION AND TACHYCARDIA

- The noxious stimulus carried by the sensory nerves below the level of the lesion of the spinal cord, activates sympathetic nerves causing massive vasoconstriction, increased blood pressure and bradycardia. Hypotension and tachycardia are not the manifestations of autonomic hyperreflexia.
IT IS PREVENTED BY BLOCKING AFFERENT VISCERAL PATHWAYS

Autonomic hyperreflexia occurs following spinal shock and in association with return of reflexes. Stimulation (bladder and bowel usually) below the spinal cord transection initiates afferent impulses that enter the spinal cord. These impulses initiate a sympathetic nervous system activity which is uninhibited by inhibitory impulses from above the level of the transection, leading to systemic hypertension and reflex bradycardia which are the hallmarks of this condition. Blocking the afferent visceral pathways by spinal anesthesia could be effective in prevention. Epidural anesthesia, deep general anesthesia and local anesthesia may or may not prevent the occurrence. Regardless of the technique used, vasodilator drugs with a short half life should be readily available.

Stoelting’s textbook of coexisting diseases fifth ed, chapter 10 B, pp 242
4. Each of the following parameters of cerebral perfusion and metabolism is approximately equal to 50 except

Please click on answer choices

A. Cerebral oxygen consumption in mls O2/min for a normal adult
B. Normal cerebral blood flow in mls/100gm/min
C. PaO2 at which cerebral blood flow increases
D. PaCo2 at which cerebral blood flow doubles

go to Q 5
A. CEREBRAL OXYGEN CONSUMPTION IN MLS O2/MIN FOR A NORMAL ADULT

The adult brain weighs 1350g. It receives 12-15% of cardiac output. The average rate of O2 consumption is 3.5ml/100g of brain tissue. Whole brain O2 consumption is thus 13.5X 3.5=47ml/min at rest.
Normal global cerebral blood flow is 45-55ml/100g of brain tissue.
D. **PAO2 AT WHICH CEREBRAL BLOOD FLOW INCREASES**

- Changes in PaO2 from 60 to 300mmHg have little effect on cerebral blood flow. When PaO2 drops to less than 60, there is a rapid increase in cerebral blood flow. The peripheral and neuraxial chemoreceptors and local humoral influences mediate cerebral vasodilatation during hypoxia.

**Incorrect**

**Try again!!**
E. PACO2 AT WHICH CEREBRAL BLOOD FLOW (CBF) DOUBLES

CBF varies directly with Paco2. CBF changes 1 to 2 mL/100 g/min for each 1 mm Hg change in Paco2 around normal Paco2 values. The mechanism of the vasodilatory response is NO, of neuronal origin, which is an important but not exclusive mediator of CO2-induced vasodilation. The vasodilatory response to hypercapnia is also mediated in part by prostaglandins. The CBF changes in response to alterations in Paco2 rapidly occur, are not sustained. Despite the maintenance of an increased arterial pH, CBF returns toward normal over a period of 6 to 8 hours because the pH of cerebrospinal fluid (CSF) gradually returns to normal levels as a result of extrusion of bicarbonate.

Ref: Millers textboookof anesthesia, 8th ed, ch 17, Piyush M.Patel, John Drummond, Brian P. Lemkul pg 393
5. During carotid endarterectomy, blood pressure suddenly decreases from 140/90 mm Hg to 80/50 mm Hg. The EKG shows a HR of 42/min with normal sinus rhythm and occasional premature ventricular contractions. The most appropriate therapy is IV administration is

Please click on answer choices

A. **Atropine**
B. **Epinephrine**
C. **Isoproterenol**
D. **Lidocaine**
E. **PhenylNephrine**
Surgical manipulation of the carotid sinus with activation of the baroreceptor reflexes can cause abrupt bradycardia and hypotension. Although cessation of surgical manipulation could promptly restore the hemodynamics, administration of IV atropine would help this situation. Infiltration of the carotid bifurcation with 1% lidocaine usually prevents further episodes.

A recent, large retrospective study reported asystole in 4.9% of patients after carotid stenting. Asystole was more likely to occur in patients undergoing a right-sided procedure, in those with significant contralateral stenosis, and in those with a reduced left ventricular ejection fraction. The administration of prophylactic atropine before balloon inflation decreases the incidence of intraoperative bradycardia and cardiac morbidity in primary carotid stenting patients.

Satya K; J Endovasc Ther 2011; 18:513-517
Millers textbook of anesthesia: E.Norris, ch 69:pg 2150
B. EPINEPHRINE

Epinephrine would not be the first choice in this situation. Using epinephrine could also contribute to increase myocardial demand in these patients with pre-existing predisposition to myocardial ischemia.
C. ISOPROTERENOL

- Although isoproterenol has been used for heart block, it is not indicated and could be detrimental in this patient with sinus bradycardia due to carotid manipulation.
D. LIDOCAINE

- IV lidocaine is not indicated at this point. Infiltration of the carotid bifurcation with 1% lidocaine usually helps to prevent further episodes. Infiltration may, however, increase the incidence of both intraoperative and postoperative hypertension.
E. PHENYLEPHRINE

Since the cause of this bradycardia is surgical manipulation of the carotid sinus, administration of the above medication would not be the first choice.

However, arterial blood pressure should be maintained in the high-normal range throughout the procedure which may need utilization of a medication like phenylephrine with its vasopressor effect particularly during the period of carotid clamping in an attempt to increase collateral flow and prevent cerebral ischemia. This may be of use particularly in patients with contralateral internal carotid artery occlusion or severe stenosis.