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Mannitol vs. Hypertonic Saline for the Management of Elevated Intracranial Pressure in Traumatic Brain Injuries

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Abstract

Traumatic brain injuries (TBI) can affect anyone who has sustained a physical blow or force to the head. Popular contact sports and summer activities can be setting for this kind of injury. Elevated intracranial pressure (ICP) can result from the swelling the brain develops after sustaining a TBI. Medications such as hypertonic saline (HTS) and mannitol can be administered to decrease ICP and preserve neural tissue. This research paper synthesizes on primary literature on the use of both HTS and mannitol in the treatment of TBI. It was determined that the overall best choice for treating TBI patients with elevated ICP is HTS. The key factors were the administration of the frug, patient;'s metabolic stress response, analysis of ICP and cerebral perfusion pressure (CPP) as well as neurological outcomes. HTS was found to provide better benefits while decreasing ECP in TBI patients. Mannitol was determined to be a great second option as evidenced suggests that it too can provide therapeutic benefits in lowering ICP. TBI's occur so often that understanding how medication help patients recover is important. This analysis can provide some insight for healthcare providers who may want additional understanding of these two medications. Having a deeper understating of ICP,CPP, and neurological outcomes in TBI patients should be a top priority to help patients return to their baseline neurological status.

DESCRIPTION

- CSF osmolarity showed the greatest increase in 72 hour group, reaching close to 315 mOsm/kg, whereas the 24-48 group's CSF osmolarity reached a max of about 297 mOsm/kg (Polderman et al., 2003).
- Studies suggests that hyperosmotic agents reduce the brain water content in a relative fashion to decrease cerebral edema.
- The metabolic variables such as reactive oxygen species (ROS), nitric oxide (NO) and total antioxidant power (TAP) measured.
- Patients that had sustained TBI had significantly higher initial levels of ROS. After therapies were initiated, ROS decreased in all groups with significance for HTS groups (p = 0.001) and mannitol group (p = 0.003).
- Levels of NO were elevated with the mannitol group having a value of 12.17 mM, bolus group of 5% HTS having 14.03 mM, and the infusion group of 5% HTS having a value of 16.9 mM. NO was able to decrease in the infusion group (p = 0.002) but increased in the mannitol group (p = 0.02).
- For TAP, the mannitol group had a value of 331.8 uM, the bolus 5% HTS group had a value of 348.07 uM, and the infusion of 5% HTS group had a value of 216.5 uM. The levels of TAP decreased in all treatment groups, with the mannitol group having the most significance (p=0.004).
- Both mannitol and HTS were able to provide the adequate adjustment for decreasing ICP. As for the CPP, the presence of both agents did help increase CPP. A noticeable difference between the groups was that HTS had achieved a larger CPP than mannitol after 30 minutes, but after 120 minutes both had a similar CPP around 74 mmHg (Cotteneceau et al., 2012).

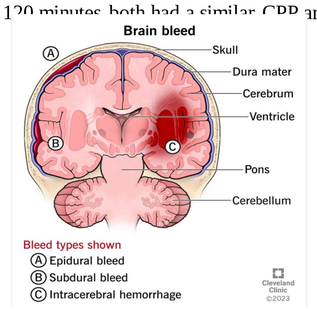

Fig. 1 The three main types of bleeds include epidermal bleed that is located outside the dura mater. A subdural bleed located under the dura mater. An intracranial hemorrhage is one that occurs within the interior of the brain more closer to internal structures near the midbrain.

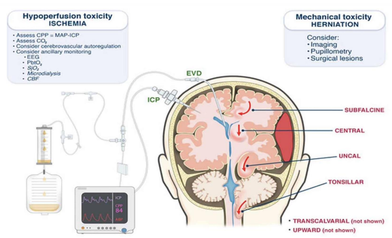

Fig. 2. A virtual representation of how monitoring of important parameters in TBI. These monitors are introduced into the internal portions of the brain and can monitor ICP and CPP.

SYNTHESIS

- The use of HTS and mannitol have both suggested effective treatment for intercranial hypertension, with HTS being a better option in most cases.
- Under metabolic conditions, stress can be a natural response by the body following a TBI. A cascade of processes begins and leads to damaging effects on cells that can be from ischemia, inflammatory, and cytotoxic pathways. The use of 5% HTS had a more efficient response to oxidants than mannitol, helping against harmful cellular activities (Veenith et al., 2009)
- In regard to ICP and CBF, the use of HTS and mannitol both provide action to decrease ICP in the setting of ICH, although HTS was able to have a longer and stronger affect in CBF, important for cerebral ischemia (Cottenceau et al., 2011).
- HTS had better results in lowering ICP than mannitol with patients receiving HTS having spent less time in the hospital as well (Mangat et al., 2015).
- Future endeavors for this field of medicine include doing more research on how the use of hyperosmotic agents can increase life after the hospital, and attempting to detect a correlation in which medication will serve best for each patient scenario.

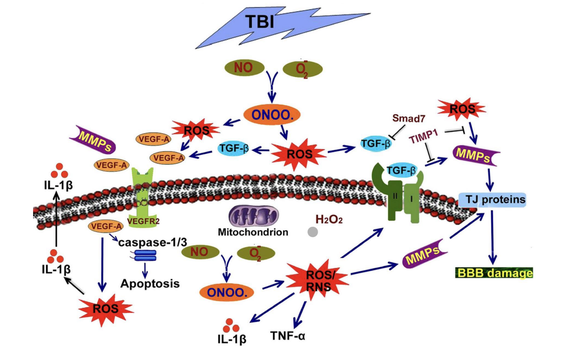

Fig. 3 TBI can promote the release of harmful reactive oxidant species (ROS) and reactive nitrogen species (RNS) causing oxidative stress. Matrix metalloproteinases (MMPs) can then begin to degrade tight junctions proteins (TJ). MMPs can also increase vascular endothelial growth factor (VEGF) and high levels can trigger apoptosis. Inflammation is also triggered by ROS and RNS by releasing cytokines.

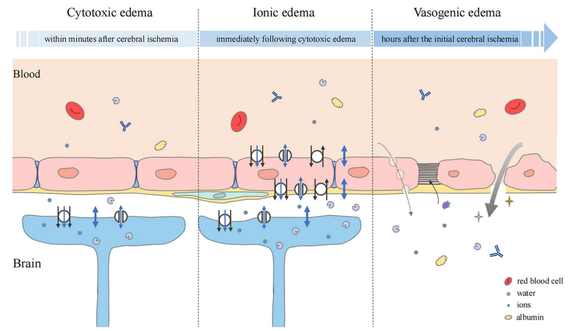

Fig. 4. These are the types of situations that can cause the brain to swell. This occurs within the blood brain barrier lining. The three types include cytotoxic edema, ionic edema, and Vasogenic edema.

FUTURE DIRECTION

- More research on how the use of hyperosmotic agents can increase life after the hospital.
- Attempting to detect a correlation in which medication will serve best for each patient scenario.
- Determining methods for early administration of hyperosmotic agents to help patients that have a chance of survival.
- In group that received the continuous infusion of 3% HTS, the mortality rate was 23%, compared to 29% for the group that did not receive HTS and considered not statistically significant (Arima et al., 2016).
- The survival rate in group receiving 7.5% HTS and group receiving lactate ringers (LR) were similar, with 63 patients from the HTS group (55%) and 57 patients from the LR group (50%). At the six-month mark, the survival rate in the HTS group was 62 patients (55%) versus 53 patients from the LR group (47%) (Cooper et al., 2004).

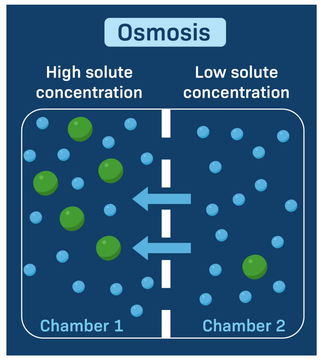

Fig. 5 The concept of how water is able to move by following a concentration gradient of solute. Water moves towards areas of higher concentration of solute creating an osmotic drive.

REFERENCES

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