Osmotherapy and the management of traumatic brain injury: still a dilemma

Despite extensive study and use, selecting an osmotherapy agent for traumatic brain injury remains a dilemma. This article explores the challenges in managing patients with traumatic brain injury and the ongoing debate surrounding the efficacy of different hyperosmolar agents as treatment options.

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Introduction

More than 70 million people worldwide experience traumatic brain injury each year (Dewan et al, 2019). Traumatic brain injury is the leading cause of death and disability globally (Dewan et al, 2019), and poses significant physical, psychiatric, emotional and financial challenges. Traumatic brain injury leads to critical alterations in brain function, so early recognition and immediate management are crucial. Management of patients with traumatic brain injury is multifactorial and includes a target mean arterial pressure of >80 mmHg, ensuring normocapnia and normoxia, and maintaining normothermia. Additionally, measures must be taken to prevent and/or manage seizures and treat coagulopathy to avoid secondary brain injury (Scerrati et al, 2018).

Osmotherapy is also a key recommendation to reduce cerebral oedema and manage intracranial pressure post-traumatic brain injury. The two main treatment options for osmotherapy are mannitol and hypertonic saline. This article considers the role of these in relation to a case study.

Case study

A 29-year-old male was brought to the emergency department by ambulance, intubated and ventilated following severe traumatic brain injury sustained in a motorbike crash. His initial Glasgow Coma Scale was 14/15, which rapidly dropped to 3/15. He received mannitol during the transport and required decompressive craniectomy to manage severe traumatic brain injury. This article looks at the evidence to see whether the outcome might have been different if hypertonic saline had been used instead.

Using mannitol to reduce intracranial pressure in patients with traumatic brain injury

Mannitol is an osmotic diuretic used to manage cerebral oedema and raised intracranial pressure (Grape and Ravussin, 2012). It causes vasoconstriction and decreases cerebral metabolic rate. However, mannitol can cause acute renal failure, re-bound cerebral oedema and hypotension, which may lead to secondary brain injury (Grape and Ravussin, 2012).

Using hypertonic saline to reduce intracranial pressure in patients with traumatic brain injury

Hypertonic saline is highly effective in promoting the shift of water between the cells and the interstitial space (Grape and Ravussin, 2012). It acts rapidly, and the effects last up to 12 hours after administration, compared to mannitol which lasts 1.5–6 hours (Grape and Ravussin, 2012). Use of hypertonic saline may result in hypernatraemia, hyperchloraemic metabolic acidosis, hyperoncotic haemolysis and pulmonary oedema (Grape and Ravussin, 2012). Hypertonic saline is administered via central venous catheter as it cannot be administered peripherally because it can cause intense irritation and there is a risk of thrombophlebitis (Webster et al, 2015).

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Mangat et al (2020) reported that hypertonic saline reduces patients' intracranial pressure without compromising cerebral perfusion. However, a high sodium load may lead to cerebral pontine myelinolysis, and use of hypertonic saline has not shown an overall difference in neurological outcome compared to mannitol if used in the pre-hospital, emergency department or intensive care settings (White et al, 2006).

Mangat et al (2015) conducted a retrospective study to determine the effects of 20% mannitol and 3% hypertonic saline on daily intracranial pressure burden (hours/day), the total number of days on the intensive care unit, the number of intensive care unit monitoring days and 2-week mortality in two groups. They found that hypertonic saline was superior to mannitol in reducing the daily intracranial pressure burden in patients following decompressive craniotomy, but the overall mortality was not significantly different between the mannitol and hypertonic saline groups.

Conclusions

The debate about whether to use mannitol or hypertonic saline is not yet resolved. Trials, observational studies and reviews have been published, but none has presented any conclusive results. There is no significant difference in the mortality rate and neurological outcome associated with the use of hypertonic saline or mannitol following traumatic brain injury.

Choosing a hyperosmolar substance, such as mannitol or hypertonic saline, requires meticulous evaluation of the agent's safety profile and potential adverse effects. This should take into account the specific characteristics of the patient and their medical condition. Furthermore, it is crucial to consider the accessibility of the selected agent, familiarity with its administration and the feasibility of using central or peripheral intravenous access.

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