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CARE OF BRAIN INJURY PATIENT : REVISITED.

Anaesthesiology

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ABSTRACT

Head injury is an important cause of morbidity and mortality throughout the world. It invariably leads to brain injury. Brain injury can be primary or secondary. Detailed discussion about diagnosis, monitoring and ICU management of brain injury patient ensues in the following text.

KEYWORDS

Brain Injury, Traumatic Brain Injury, Care Of Head Injured Patient, Critical Care.

INTRODUCTION

Head trauma is otherwise called traumatic brain injury(TBI). TBI occurs in two phases, Primary and Secondary brain injury.

Primary injury: Results from the direct physical impact to the brain parenchyma resulting in structural and shearing injury of neurons, injury to vessels, and interruption of neurochemical processes. This leads to hemorrhage, edema, compression of intracranial structures.

Secondary injury: It is characterized by a cascade of events that starts within minutes of the primary injury. As in ischemia-reperfusion injuries, the acute post-injury period in TBI is characterized by several pathophysiologic processes that start in the minutes to hours following injury and may last for hours to days.

Secondary, systemic brain insults are mainly ischemic in nature;

- Hypotension (systolic blood pressure [SBP] < 90 mm Hg)
- Hypoxemia (PaO2 < 60 mm Hg; O2 Saturation < 90%)
- Hypocapnia (PaCO2 < 35 mm Hg)
- Hypercapnia (PaCO2 > 45 mm Hg)
- Hypertension (SBP > 160 mm Hg, or mean arterial pressure [MAP] > 110 mm Hg)
- Anemia (Hemoglobin [Hb] < 10.0 g/dL, or hematocrit [Ht] < 0.30)
- Hyponatremia (serum sodium < 142 mEq/L)
- Hyperglycemia (blood sugar > 10 mmol/L)
- Hypoglycemia (blood sugar < 4.6 mmol/L)
- Hypo-osmolality (plasma osmolality [P Osm] < 290 mOsm/Kg H2O)
- Acid-base disorders (acidemia: pH < 7.35; alkalemia: pH > 7.45)
- Fever (temperature > 36.5°C)
- Hypothermia (temperature < 35.5°C)

DISCUSSION

ICU Management:

- Prior to arrival to the ICU, patients with severe TBI are usually received, resuscitated and stabilized in emergency department or operating room.
- Once the severely head-injured patient has been transferred to the ICU, the management consists of the provision of high quality general care and various strategies aimed at maintaining hemostasis with:
- Stabilization of the patient, if still unstable
- Prevention of intracranial hypertension
- Maintenance of an adequate and stable cerebral perfusion pressure (CPP)
- Avoidance of systemic, secondary brain insults (SBI)
- Optimization of cerebral hemodynamics and oxygenation

General Monitoring:

- Electrocardiography (ECG monitoring)
- Arterial oxygen saturation (pulse oxymetry, SpO2)
- Capnography (end-tidal CO2, PetCO2)
- Arterial blood pressure (arterial catheter)
- Central venous pressure (CVP)
- Systemic temperature
- Urine output
- Arterial blood gases
- Serum electrolytes and osmolality.

Intacranial Pressure Monitoring:

Intracranial pressure monitoring uses a device, placed inside the head, which senses the pressure inside the skull and sends its measurements to a recording device. Range 3-15mmHg

- Noninvasive ICP monitoring
- Invasive ICP monitoring

Noninvasive ICPM: The most important tool for diagnosing potential elevation of ICP and monitoring its progression is the clinical neurological examination.[1] The patient should be evaluated for the following:

- Headache, nausea, and vomiting
- Degree of alertness or consciousness (Glasgow coma score)
- Language comprehension, repetition, fluency, articulation
- Pupillary reactivity (Pupillary asymmetry or anisocoria of more than 2 mm should be noted.)
- Extraocular movements and visual fields in all quadrants.
- Funduscopic examination (This also remains the criterion standard in the evaluation of increased ICP.)
- Vital signs (Note particularly the absence or presence of Cushing triad: respiratory depression, hypertension, bradycardia.)

Imaging:

Noncontrast CT scanning of the head is a fast, cost-effective method to evaluate for elevated ICP and associated pathology. Findings suggestive of elevated ICP are as follows:

- Intracranial blood/bony fractures
- Mass lesions
- Obstructive hydrocephalus
- Cerebral edema (both focal or diffuse)
- Midline shift

Invasive Intracranial Pressure Monitoring:

INDICATION:

- Patient with GCS less than 8 after reversal of sedatives that were used during intubation
- Patient with risk of raised ICP under general anesthesia
- Unilateral or bilateral motor posturing
- Indication for closed head injury

Tecnhiques:

1. External ventricular drain[2] placement (EVD) or ventriculostomy
2. Intraparenchyma fiberoptic catheter placement

EVD PLACEMENT:

- An EVD is a highly accurate tool for monitoring ICP.
- It requires placement of a catheter into the lateral ventricle at the level of the foramen of Monro.
- Benefit:
- In addition to monitoring, an EVD allows for therapeutic relief of elevated ICP via CSF drainage.

Disadvantages :

- Parenchymal hematoma and infection/ventriculitis.
- Obstruction of the drain requires replacement.
- Continuous monitoring requires nursing staff to be educated on management of the EVD.

Intraparenchymal fiberoptic catheter: It is used to measure the ICP without CSF diversion.

Benefit:
- It has a lower complication rate, lower infection rate, and no chance of catheter occlusion or leakage.
- Neurological injury is minimized because of the small diameter of the probe.
- Malpositioning of the transducer has less impact on errors of measurement.

Disadvantage**:** Can't drain CSF.

Electrophysiological Monitoring:
Electroencephalogram (EEG) is a clinically useful tool for monitoring the depth of coma, detecting non-convulsive (sub-clinical) seizures or seizures activity in pharmacologically paralyzed patients, and diagnosing brain death.

Analgesia, Sedation and Paralysis:
- In severe TBI patients, endotracheal intubation, mechanical ventilation, trauma, surgical interventions (if any), nursing care and ICU procedures are potential causes of pain.
- Narcotics, such as fentanyl and remifentanil, should be considered first line therapy since they provide analgesia, mild sedation and depression of airway reflexes (cough) which all required in intubated and mechanically ventilated patients.
- Propofol is the hypnotic of choice in patients with an acute neurologic insult, as it is easily titratable and rapidly reversible once discontinued.
- Benzodiazepines

Mechanical Ventilation:
- Patients with severe TBI are usually intubated and mechanically ventilated.
- Hypoxia, defined as O_2saturation < 90%, or PaO2 < 60 mm Hg, should be avoided.
- Prophylactic hyperventilation to a $PaCO_2$ < 25 mm Hg is not recommended
- Within the first 24 hours following severe TBI, hyperventilation should be avoided, as it can further compromise an already critically reduced cerebral perfusion.
- Excessive and prolonged hyperventilation results in cerebral vasoconstriction and ischemia. Thus, hyperventilation is recommended only as a temporizing measure to reduce an elevated ICP.
- A brief period (15-30 minutes) of hyperventilation, to a PaCO2 30-35 mm Hg is recommended to treat acute neurological deterioration reflecting increased ICP.

Hemodynamic Support:
- Hemodynamic instability is common in patients with TBI.
- Hypotension is a frequent and detrimental secondary systemic brain insult and has been reported to occur in up to 73% during ICU
- Appropriately aggressive fluid administration to achieve adequate intravascular volume is the first step in resuscitating a patient with hypotension following TBI.
- The CVP may be used to guide fluid management and is recommended to be maintained at 8 - 10 mm Hg.
- In patients who respond poorly to adequate volume expansion and vasopressors, demonstrate hemodynamic instability, or have underlying cardiovascular disease, a pulmonary artery catheter or non-invasive hemodynamic monitoring may be considered.
- Isotonic crystalloids, specifically normal saline (NS) solution are the fluid of choice for fluid resuscitation and volume replacement.
- Anemia is a common secondary systemic brain insult and should be avoided, with a targeted hemoglobin ≥10 mg/dL or hematocrit ≥0.30.
- Brain tissue is reach in thromboplastin and cerebral damage may cause coagulopathy. Coagulation abnormalities should be aggressively corrected with blood products as appropriate

Normothermia:
- An increase in body and brain temperature is associated with an increase in cerebral blood flow[3], cerebral metabolic oxygen requirement and oxygen utilization, resulting in an increase in ICP and further potential brain ischaemia.
- Therefore, avoidance of hyperthermia should be one of the mainstays of head-injury management; it may require the use of pharmacological antipyretics and surface cooling measures.

Cerebral Perfusion Pressure:
- Cerebral ischemia is considered the single most important secondary event affecting outcome following severe TBI.
- CPP, defined as the (CPP = MAP - ICP), below 50 mm Hg should be avoided.
- A low CPP may jeopardize regions of the brain with pre-existing ischemia, and enhancement of CPP may help to avoid cerebral ischemia.
- The CPP should be maintained at a minimum of 60 mm Hg in the absence of cerebral ischemia, and at a minimum of 70 mm Hg in the presence of cerebral ischemia.

Hyperosmolar Therapy:
- Mannitol administration is an effective method to decrease raised ICP after severe TBI.
- Mannitol creates a temporary osmotic gradient and it increases the serum osmolarity to 310 to 320 mOsm/kg H2O.
- The effective dose is 0.25-1 g/kg, administered intravenously over a period of 15 to 20 minutes. The regular administration of mannitol may lead to intravascular dehydration, hypotension, pre-renal azotemia and hyperkalemia.
- Mannitol is contraindicated in patients with TBI and renal failure because of the risk of pulmonary edema and heart failure.

Anti-seizure Prophylaxis:
- Post-traumatic seizures are classified as early occurring within 7 days of injury, or late occurring after 7 days following injury.
- Prophylactic therapy (phenytoin, carbamazepine, or phenobarbital) is not recommended for preventing late post-traumatic seizures.
- Phenytoin is the recommended drug for the prophylaxis of early post-traumatic seizures.
- A loading dose of 15 to 20 mg/kg administered intravenously (I.V.) over 30 minutes followed by 100 mg, I.V., every 8 hours, for 7 days, is recommended.
- Patients receiving antiseizures prophylaxis should be monitored for potential side effects.

DVT Prophylaxis:
- Mechanical thromboprophylaxis, including graduated compression stockings and sequential compression devices, are recommended unless their use is prevented by lower extremity injuries.
- The use of such devices should be continued until patients are ambulatory.
- In the absence of a contraindication, low molecular weight heparin (LMWH) or low dose unfractionated heparin should be used in combination with mechanical prophylaxis.

Nutritional Support:
- There is evidence suggesting that malnutrition increases mortality rate in TBI patients.[4]
- Early enteral feeding is recommended than parenteral in patients with severe TBI, as it is safe, cheap, cost-effective, and physiologic.
- The potential advantages of enteral feeding include stimulation of all gastro-intestinal tract functions, preservation of the immunological gut barrier function and intestinal mucosal integrity, and reduction of infections and septic complications.

General Intensive Care:
- Raising head of bed to 30° - 45°: that would reduce ICP and improves CPP and lower the risk of ventilator-associated pneumonia (VAP).
- Keeping the head and neck of the patient in a neutral position: this would improve cerebral venous drainage and reduce ICP.
- Turning the patient regularly and frequently with careful observation of the ICP.
- Providing eye care, mouth and skin hygiene.
- Administrating a bowel regimen to avoid constipation and increase of intra-abdominal pressure and ICP.
- Performing physiotherapy.

Craniectomy:
- A bifrontal decompressive craniectomy may be performed to allow the brain tissue to expand and decrease the ICP.

CONCLUSION
- TBI is a devastating injury and often these patients would require

monitoring and treatment in intensive care unit.

- Management of TBI patients requires multidisciplinary approach, frequent close monitoring and judicious use of multiple treatments to lessen secondary brain injury and improve outcomes.

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