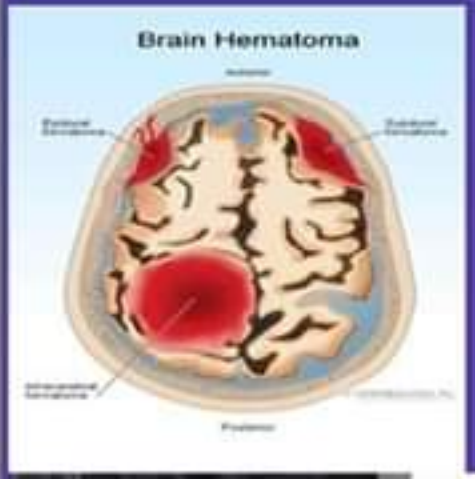
MANAGEMENT OF HEAD TRAUMA (TBI) IN ICU



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INTRODUCTION

B- Secondary Injury : it is characterized by a cascade of events that starts within minutes of the primary injury. As in ischemia –reperfusion injuries.

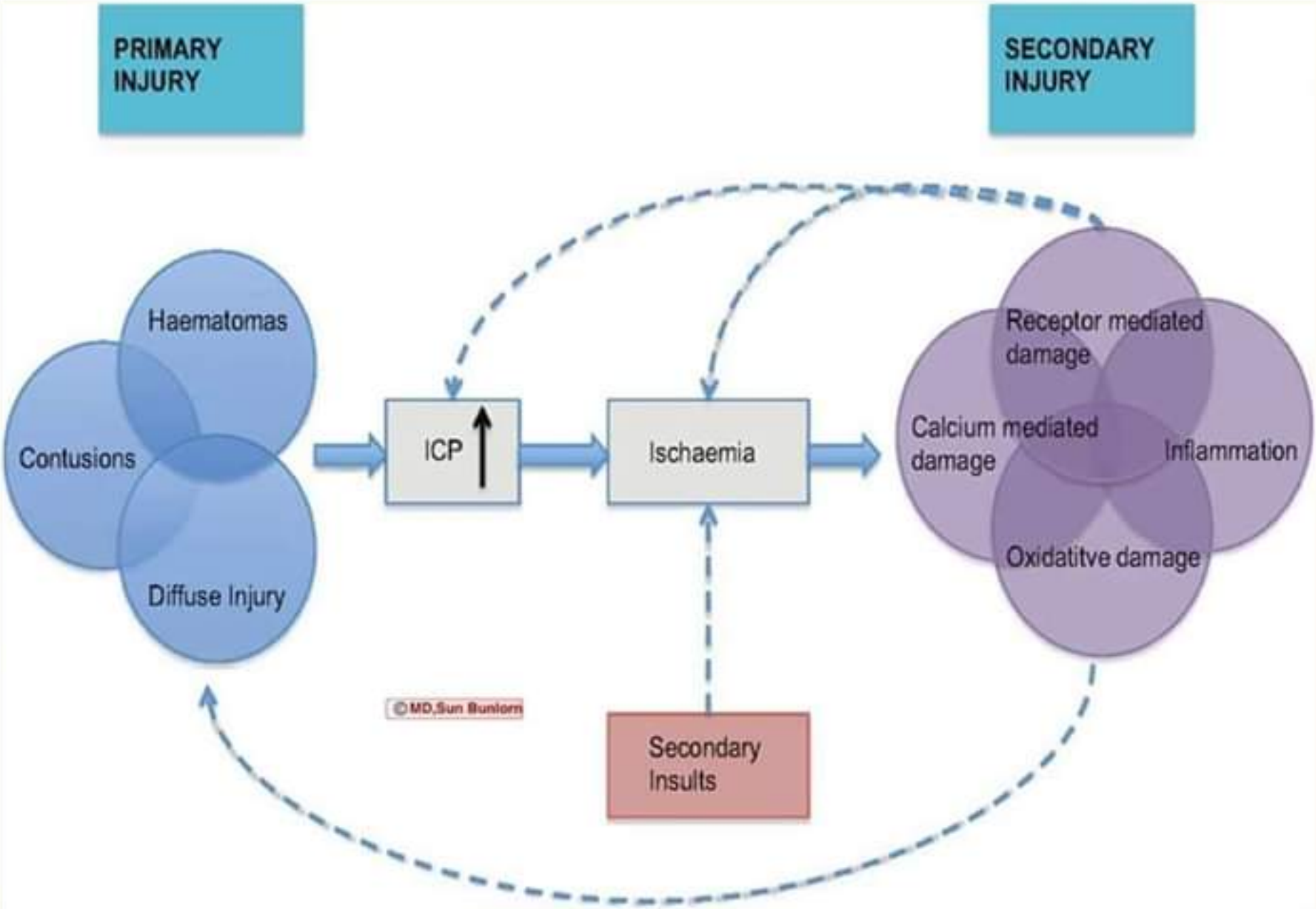
- **the acute post-injury period in TBI is characterized by several pathophysiologic processes that start in the minutes to hours following injury and may last for hours to days.**

INTRODUCTION

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

A-*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.**


PRIMARY INJURY
SECONDARY INJURY
Haematomas
Contusions
Diffuse Injury
ICP
Ischaemia
Receptor mediated damage
Calcium mediated damage
Inflammation
Oxidativte damage
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Secondary Insults

Secondary, systemic brain insults are mainly ischemic in nature;

- Hypotension (systolic blood pressure [SBP] < 90 mm Hg)
- Hypoxemia (PaO_2 < 60 mm Hg; O_2 Saturation < 90%)
- Hypocapnia ($PaCO_2$ < 35 mm Hg)
- Hypercapnia ($PaCO_2$ > 45 mm Hg)

- Hypertension (SBP > 160 mm Hg, or mean arterial pressure [MAP] > 110 mm Hg).
- Anemia (Hemoglobin [Hb] < 10 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)

MANAGEMENT IN ICU

- 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 homostasis 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 hemodynamic 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.

INTRACRANIAL PRESSURE MONITORING (ICPM)

Noninvasive
ICP monitoring

Invasive
ICP monitoring.

Noninvasive ICPM

The patient should be evaluated for the follw:

- 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.)

Optic Nerve Sheath Diameter

The probe should then be gently placed over the eyelid paying careful attention not to exert too much pressure.

Cutoff values, varying between 4.8 and 5.9mm for ICP estimation

Imaging

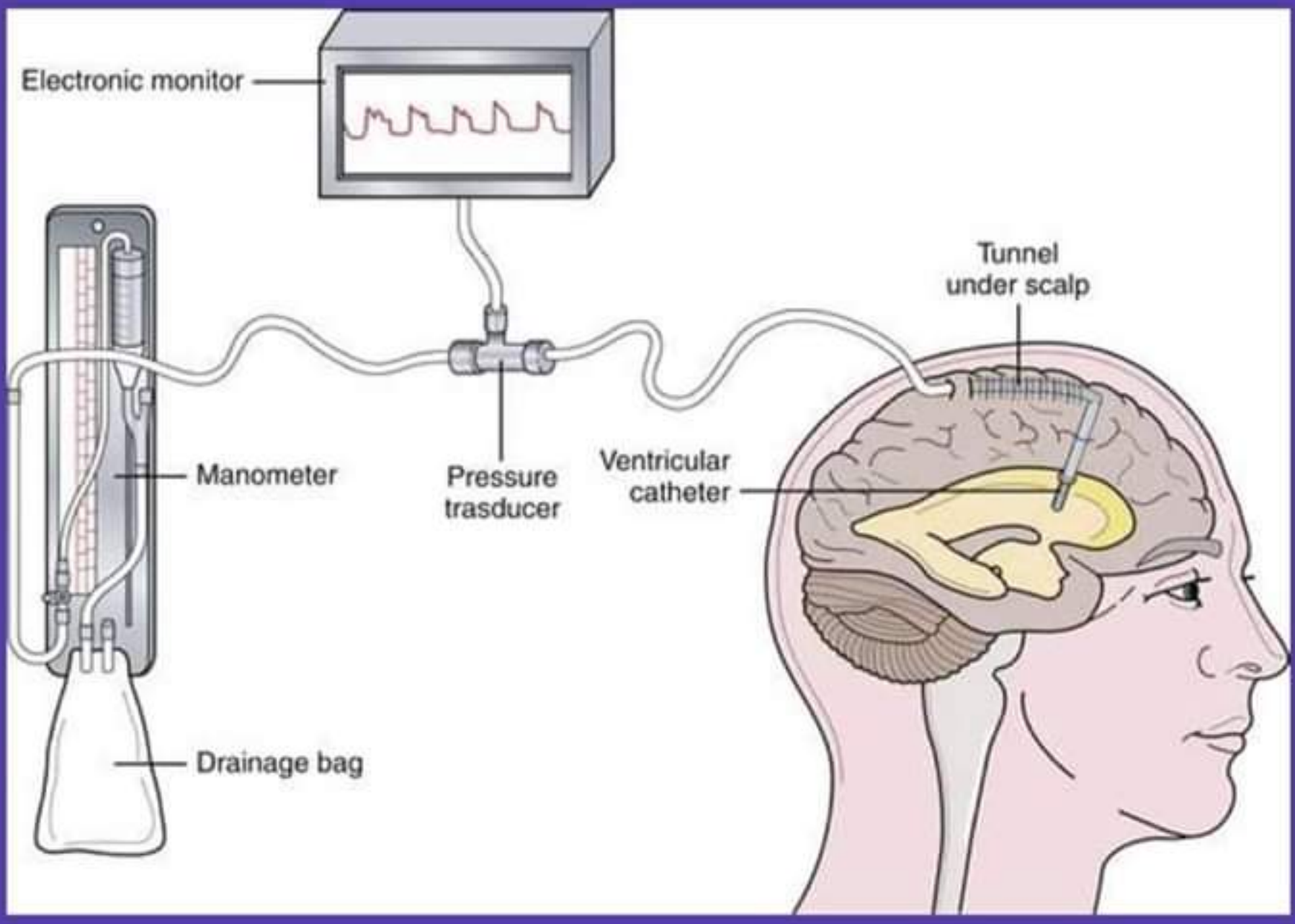
Noncontrast CT scanning of the head is a fast, cost-effective method to evaluate for elevated ICP and associated pathology.

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 ICPM

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 3-15 mmHg



Invasive ICPM

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

Invasive ICPM techniques

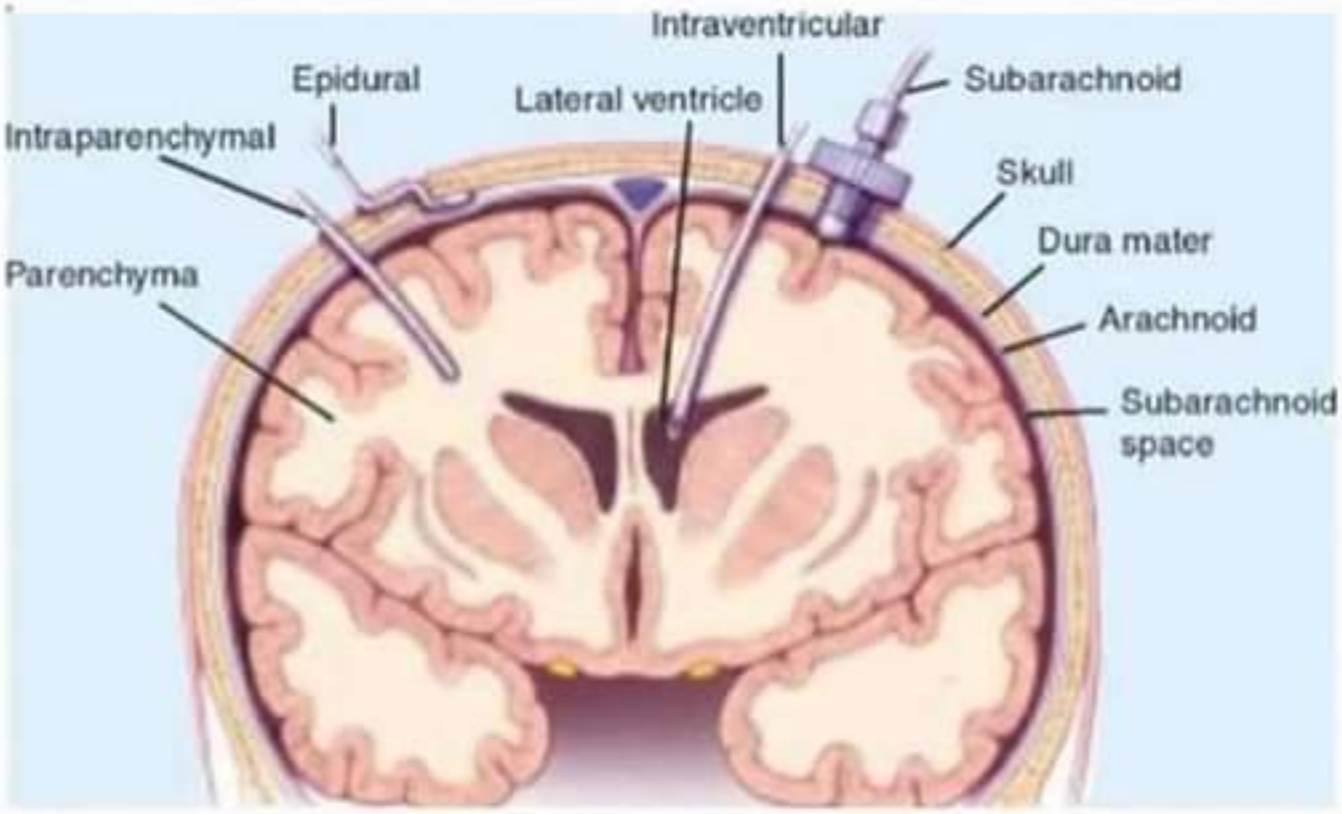
A- External ventricular drain placement (EVD) or ventriculostomy

B- 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

Various monitors



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.

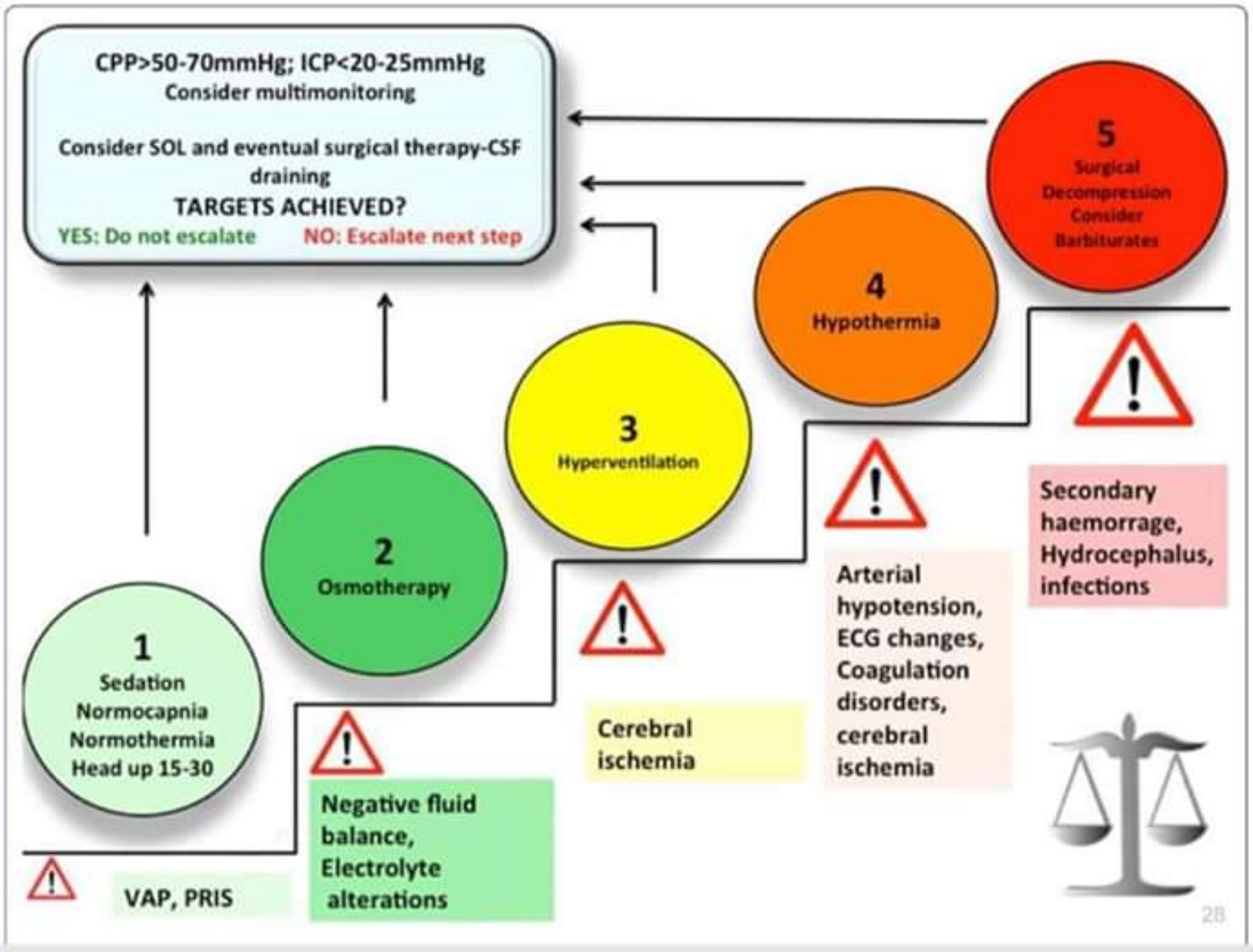
Intraparenchyma fiberoptic catheter

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

Benefit:

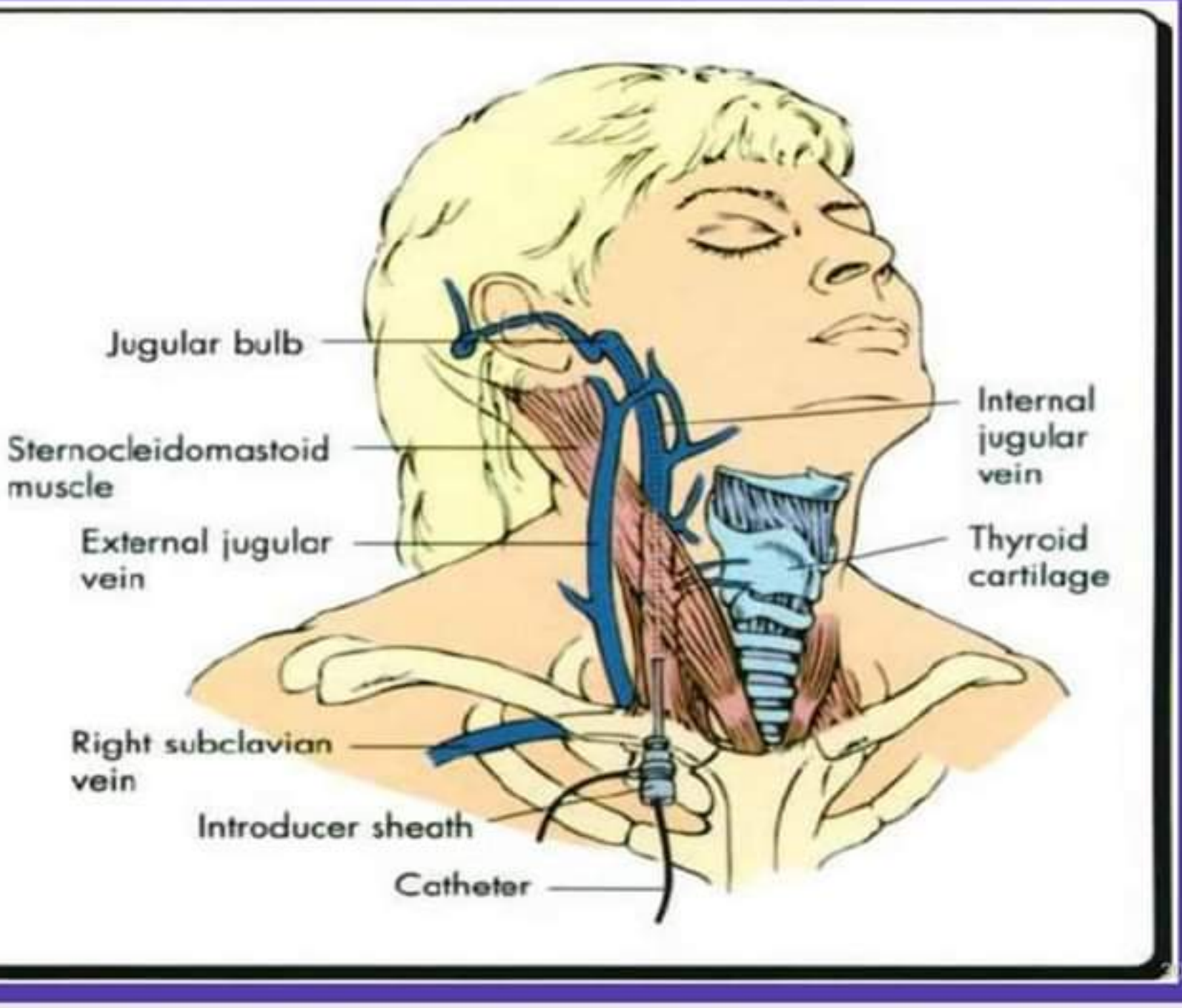
- It has a lower complication rate, lower infection rate, and no chance of catheter occlusion or leakage.
- Neurological injury is minimized because of the small diameter of the probe.
- Malpositioning of the transducer has less impact on errors of measurement.

Disadvantage : Can't drain CSF



JUGULAR BULB VENOUS OXYGEN SATURATION MONOTORING

- The jugular venous oxygen saturation (SjvO2) is an indicator and helps in reflecting the ratio between cerebral blood flow (CBF) and cerebral metabolic rate of oxygen.
- A retrograde catheterization of the internal jugular vein (IJV) is used for SjvO2 monitoring. As the right IJV is usually dominant



- The normal average of the SjvO2, in a normal awake subject, is 62% with a range of 55% to 71%.
- A sustained jugular venous desaturation of < 50% is the threshold of cerebral ischemia and for treatment.
- SjvO2 monitoring can detect clinically occult episodes of cerebral ischemia, allowing the prevention of these episodes by simple adjustment of treatment.

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 morphine, 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.

- Administration of narcotics is either as continuous infusions or as intermittent boluses.

- Propofol is the hypnotic of choice in patients with an acute neurologic insult, as it is easily titratable and rapidly reversible once discontinued.

- However, propofol should be avoided in hypotensive or hypovolemic patients because of its deleterious hemodynamic effects
- Benzodiazepines

MECHANICAL VENTILATION

- Patients with severe TBI are usually intubated and mechanically ventilated.

- Hypoxia, defined as O2 saturation < 90%, or PaO2 < 60 mm Hg, should be avoided.

- Prophylactic hyperventilation to a PaCO2 < 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 $PaCO_2$ 30-35 mm Hg is recommended to treat acute neurological deterioration reflecting increased ICP.

- Longer periods of hyperventilation might be required for intracranial hypertension refractory to all treatments including sedation, paralytics, CSF drainage, hypertonic saline solutions (HSSs) and osmotic diuretics.

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.

- Dynamic parameters may be used to guide fluid management as IVC dispensability , PPV and SVV
- In patients who respond poorly to adequate volume expansion and vasopressors, demonstrate hemodynamic instability, or have underlying cardiovascular disease, a PICCO or pulmonary artery catheter hemodynamic monitoring may be considered.

- Isotonic crystalloids, specifically normal saline (NS) (NaCL 0.9%) 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 g/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

- Hypertension is also a secondary systemic brain insult that can aggravate vasogenic brain edema and intracranial hypertension. However, hypertension may be a physiological response to a reduced cerebral perfusion.
- hypertension should not be treated unless a cause has been excluded or treated, and SBP > 180-200 mm Hg or MAP > 110-120 mm Hg.

Normothermia

- An increase in body and brain temperature is associated with an increase in cerebral blood flow, cerebral metabolic oxygen requirement and oxygen utilization, resulting in an increase in ICP and further potential brain ischemia.

- 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

OSMOTIC 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.

OSMOTIC THERAPY

- ***Hypertonic saline 5% (HTS)*** 250 ml over 20 min ,Can be used as alternative to mannitol in
  - Hypernatremia
  - Hypovolemia
  - Hypotension

ANTISEIZURE 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, titrated to plasma level, for 7 days, is recommended.

- Patients receiving antiseizures prophylaxis should be monitored for potential side effects.

DEEP VEIN THROMBOSIS PROPHYLAXIS

- Severe TBI patients are at significantly high risk of developing venous thrombo-embolic events (VTEs) including deep vein thrombosis (DVT) and pulmonary embolism.

- 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

- Severe TBI patients are usually in hypermetabolic, hypercatabolic and hyperglycemic state, with altered G.I.T Functions.

- There is evidence suggesting that malnutrition increases mortality rate in TBI patients

- 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 15° - 30°: 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.
- Avoiding compression of internal or external jugular veins with tight cervical collar or tight tape fixation of the endotracheal tube that would impede cerebral venous drainage and result in an increase in the 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.

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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