EXTERNAL VENTRICULAR DRAINS by Nick Mark MD

DEFINITION:
An EVD is a temporary closed sterile system that both invasively measures ICP and removes excess CSF. It is typically used when ICP is increased (e.g., hemorrhage, severe head trauma, large strokes, obstructing tumors). In addition to drainage of excess CSF, ICP guided medical & surgical interventions may reduce morbidity & mortality.

ICP WAVEFORM INTERPRETATION:
Examining the ICP waveform and trends can provide useful information about CNS perfusion & compliance.

SHORT TERM PATTERNS (seconds)
- P1 – related to arterial pulse; ∝ to CPP
- P2 - rebound of pulse; inversely ∝ to cerebral compliance (e.g. ↑P2 with ↓compliance)
- P3 – related to dicrotic notch in arterial pulse

NORMAL

Trimodal pattern with P1 > P2, P3 is seen normally. Increased P1 may be seen with increased SBP

INCREASED ICP

A trimodal pattern with P2 > P1, P3 suggests abnormal CNS compliance usually due to increased ICP

MARKEDLY INCREASED ICP

Loss of discreet waves is seen with markedly abnormal CNS compliance

LONGER TERM PATTERNS (minutes)
Periodic fluctuations in ICP over time fall into three discreet patterns, called Lundberg waves.

LUNDBERG A WAVES

Plateaus up to 50mmHg lasting 5-20 minutes; suggestive of impending brain herniation

LUNDBERG B WAVES

Rhythmic Spikes in ICP every 30-120 seconds suggestive of cerebral vasospasm

LUNDBERG C WAVES

Low amplitude Oscillations in ICP every 7-15 seconds that represent normal CNS homeostasis.

The MONROE-KELLI DOCTRINE:
Because the volume of the skull is fixed, brain swelling, hemorrhage, or obstructions in CSF flow (hydrocephalus) will increase ICP. As ICP rises, perfusion will decrease:

\[ CPP = MAP - ICP \]

Cerebral perfusion pressure
Mean arterial pressure
Intracranial pressure

CHOOSING EVD SETTINGS:
The objective is to use a ventriculostomy catheter and the EVD system to remove excess CSF and maintain normal CPP, while avoiding a rapid drop in ICP, which could cause re-bleeding.

The height of the drip chamber above the zero level determines at what pressure excess CSF will be drained. (e.g. if the EVD is set at 10cm above CSF will drain if the ICP is greater than 10 cmH2O)

An EVD is weaned by progressively raising the level and then clamping it, prior to removal.

Proximal port is used to sample CSF (for signs of infection, malignancy) or to instill medication (antibiotics, thrombolytic, etc)

NORMAL CSF PRODUCTION = 25 ml/hr
NORMAL ICP = 10-15 cmH2O