EXTERNAL VENTRICULAR DRAINS by Nick Mark MD

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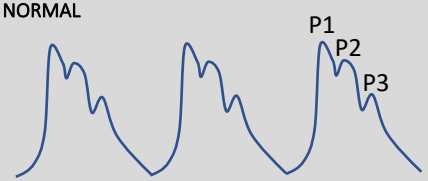
DEFINITION:
An EVD is a temporary closed sterile system that both invasively ***measures*** ICP and ***removes excess*** CSF. It is typically used when ICP is increased (e.g., hemorrhage, severe head trauma, large strokes, obstructing tumors). In addition to drainage of excess CSF, ICP guided medical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

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

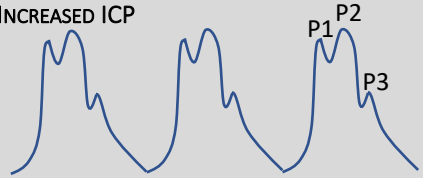
SHORT TERM PATTERNS (seconds)
P1 – related to arterial pulse; ∝ to CPP
P2 - rebound of pulse; inversely ∝ to cerebral compliance (e.g. ↑P2 with ↓compliance)
P3 – related to dicrotic notch in arterial pulse

NORMAL



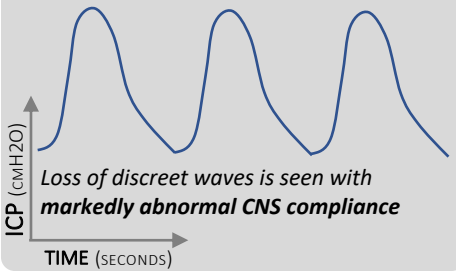
*Trimodal pattern with P1 > P2, P3 is seen **normally.** Increased P1 may be seen with increased SBP*

INCREASED ICP



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

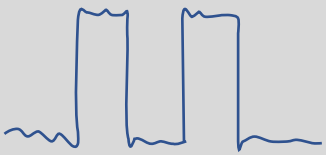
MARKEDLY INCREASED ICP



*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

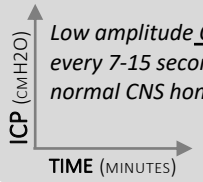


*Plateaus up to 50mmHg lasting 5-20 minutes; suggestive of impending brain **herniation***

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:

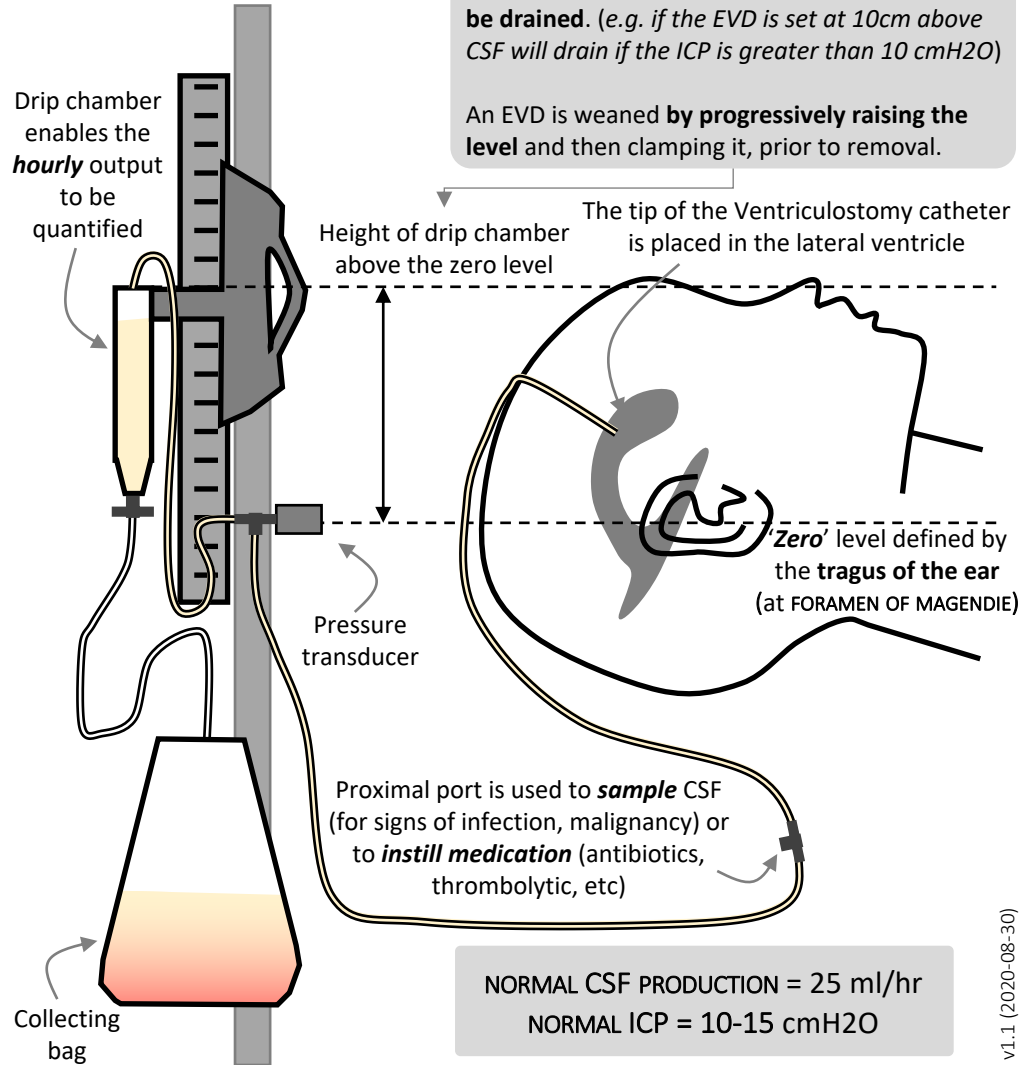
$$CPP = MAP - ICP$$

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.



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

v1.1 (2020-08-30)