

MONITORING OF RAISED INTRA CRANIAL PRESSURE AND MANAGEMENT OF RAISED INTRA CRANIAL PRESSURE

Presented By : Pankaj Singh

Normal ICP

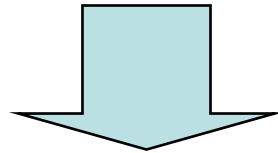
a. Adults and older children <10-15mmHg

a. Young children 3-7

a. Term Infant 1.5-6

Intra Cranial Cavity

- Volume is virtually constant
- Filled to capacity with fluids and solid material that are not compressible

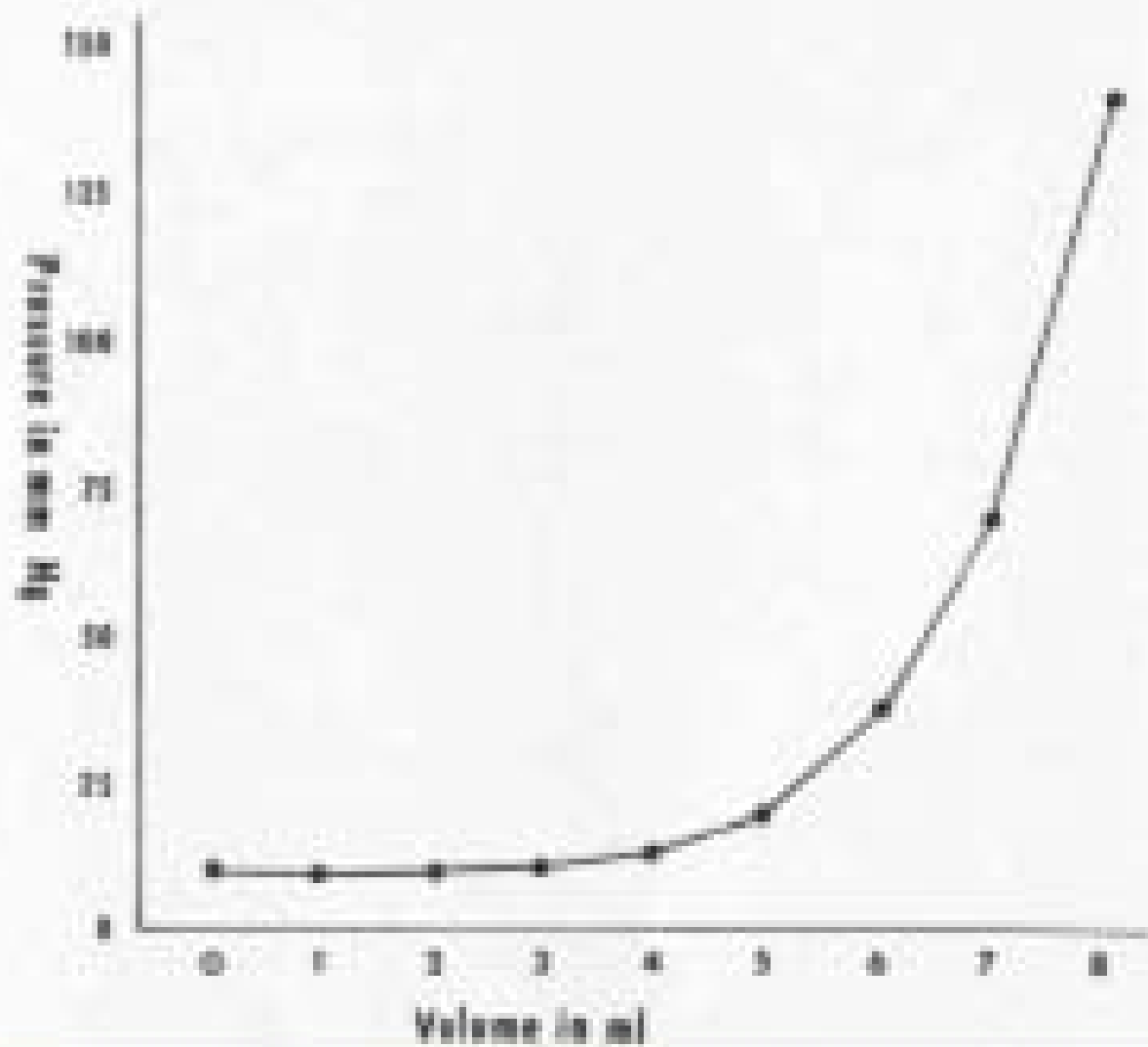


Increase in one constituent or an expanding mass within the intra cranial space results in Raised ICP (Monro Kellie Doctrine)

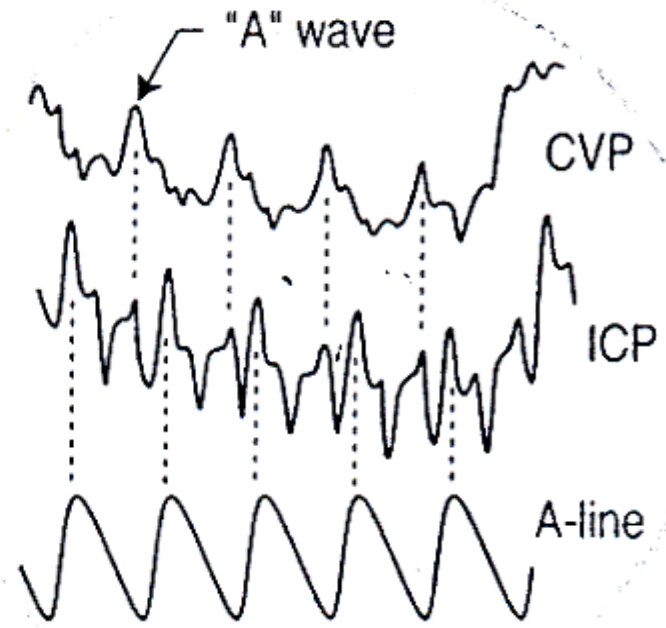
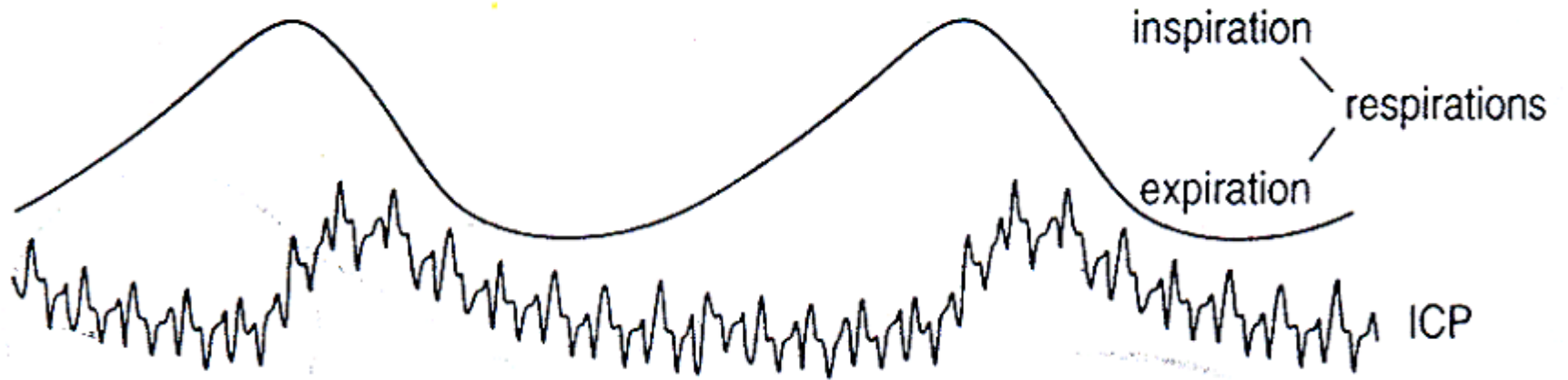
Intra Cranial Cavity Contents

- Brain (1300-1750ml)
 - Neurons 500-700ml
 - Glia 700-900ml
 - Extra cellular fluid 100-150ml
 - Blood 100-150ml
 - CSF 100-150ml
- Constituents are non compressible but partially displaceable

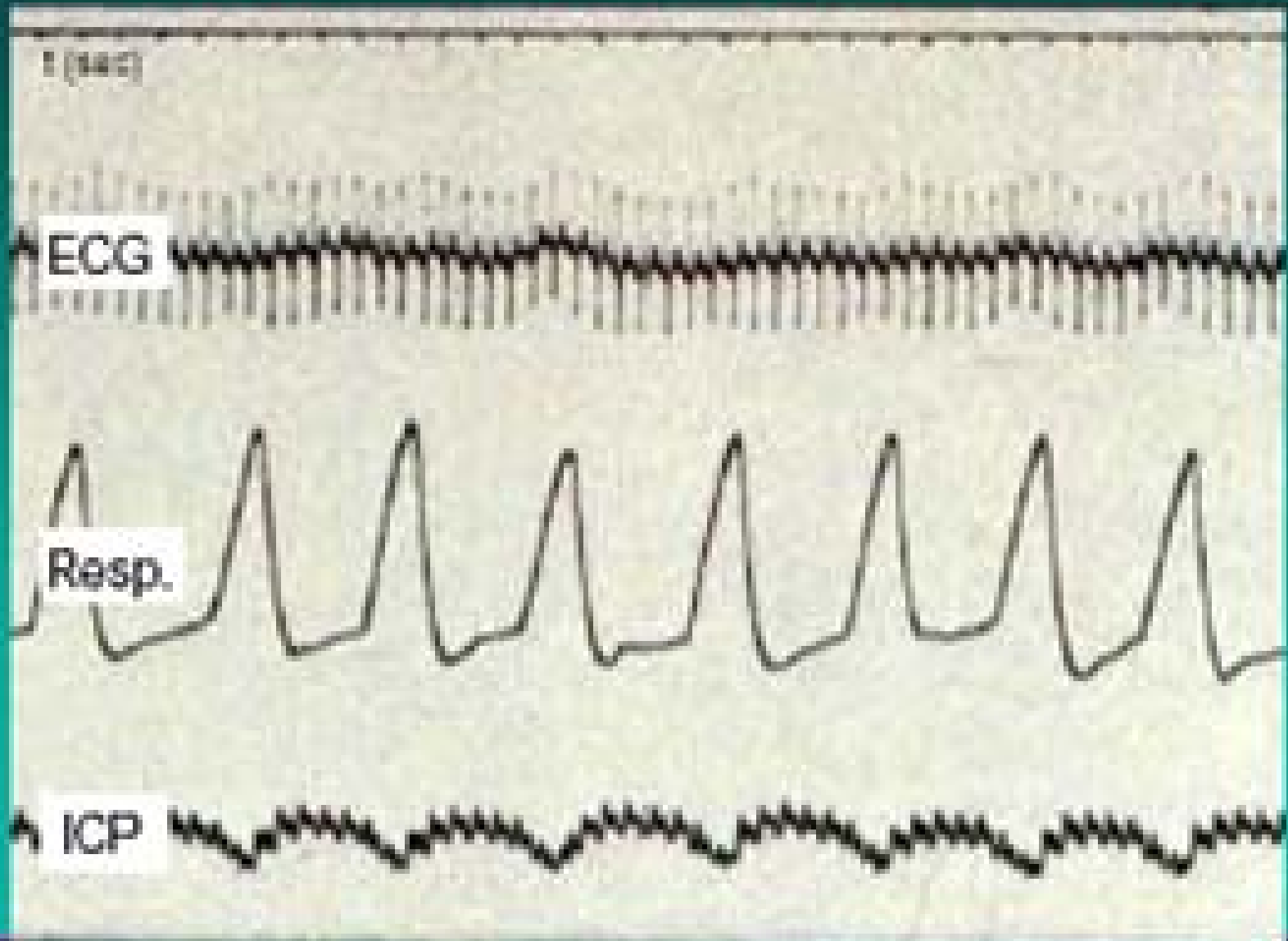
ICP/Volume Curve



ICP Wave



Normal ICP Waveform



Clinical Symptoms and Signs of Raised ICP

- Headache
- Nausea and vomiting
- Impairment of consciousness
- Papilloedema
- 6th C N Palsy – False localizing sign
- Herniation signs (late)

Causes of Increased ICP

- Increased volume of normal intracranial constituents
 - Brain – Cerebral oedema
 - CSF – Hydrocephalous
 - Blood volume – Vasodilatation secondary to increased Co_2
- Space occupying lesion – Tumour, Hematoma, Abscess,
- Idiopathic – Pseudotumour Cerebri

Cerebral Perfusion Pressure and Auto Regulation

$$CPP = MAP - ICP$$

Cerebral auto regulation is a mechanism where by over a wide range of changes in systemic BP produces only small changes in CBF

ICP

- Cerebral oedema
- Hyperemia
- Intra cranial Mass
- HCP
- Hypoventilation
- Systemic Hypertension
- Venous sinus thrombosis
- Increased Muscle tone and valsalva maneuver
- Sustained Post traumatic seizure

Secondary Increase in ICP (3-10 Days Following trauma)

- Delayed hematoma formation
- Cerebral vasospasm
- ARDS with Hypoventilation
- Delayed Oedema formation
- Hyponatremia

Cushing Triad

- Hypertension
- Bradycardia
- Respiratory Irregularity

ICP Monitoring

- Indication
 - **Severe Head injury (GCS \leq 8 after CPR) and either**
 - Abnormal admitting CT
 - Or
 - Normal CT with \geq 2 of risk factors (Age >40yr, SBP <90mm Hg, Decerebrate or decorticate posturing)
 - Multiple System Injured with altered level of consciousness
 - Traumatic Intra cranial mass
 - A physician may choose to monitor ICP in some the patients
 - Post op subsequent to removal

Contra indications

- Awake Patient
- Coagulopathy

Duration of monitoring

- Till ICP is normal for 48-72 Hours after withdrawal of therapy

Types of Monitor

- Intra ventricular catheter (Standard) –
 - **Advantages** –
 - Low cost
 - Therapeutic CSF Drainage
 - May be recalibrated to minimize measurement drift
 - **Disadvantages** –
 - Difficult to insert
 - Obstruction of fluid column
 - Some effort is required to check any monitoring function
 - Transducer must be consistently maintain at a fixed reference point

– Intra parenchymal monitor – Similar to IVC usually not subjected to measurement drift

– Less Accurate-

- Subarachnoid screw- At high ICP brain may block Lumen
- Subdural
- Epidural
- Infants-
 - Aplanation Principle
 - Fontometry

Intra Ventricular Catheter

- Right side frontal horn
- EAC is external land mark for Zeroing



SpO₂
100
90

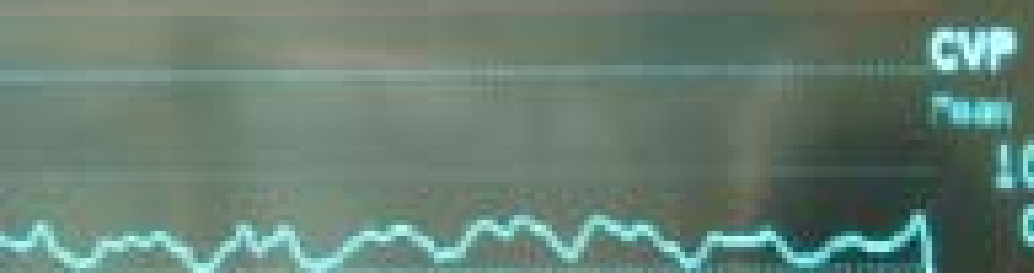
100

PVC 0
ST-T -0.5
ST-T1 -2.0
ST-AVE 0.5



ART
132
72

132/72 (89)



CVP
4

(4)



ICP
11

(11)

CPP
78



RR
33

33

Takin
37.3

Type of Wave Form

- Normal wave form
 - Small pulsation transmitted from the systolic BP to intra cranial cavity
 - Large 1-2mm Hg Peak corresponding to altered systolic Pressure wave with small dicrotic notch.
 - The Peak is followed by smaller and less distinct peak
 - Followed by peaks corresponding to central venous A wave from right atrium.
 - Blood pressure pulsation are superimposed on slower respiratory variation
- During expiration – SVC Pressure Increases so ICP increase

Pathological Wave Form

As ICP rises cerebral compliance decreased the venous component disappears and arterial pulsation become more pronounced

a. Lundberg A- (Plateau wave)

b. Lundberg B- amplitude 10-20mmHg, last 30 second to 2 minutes. Respiratory variation present.

c. Lundberg C- frequency 4-8 per Minutes.

Also called as Traube Hering Waves

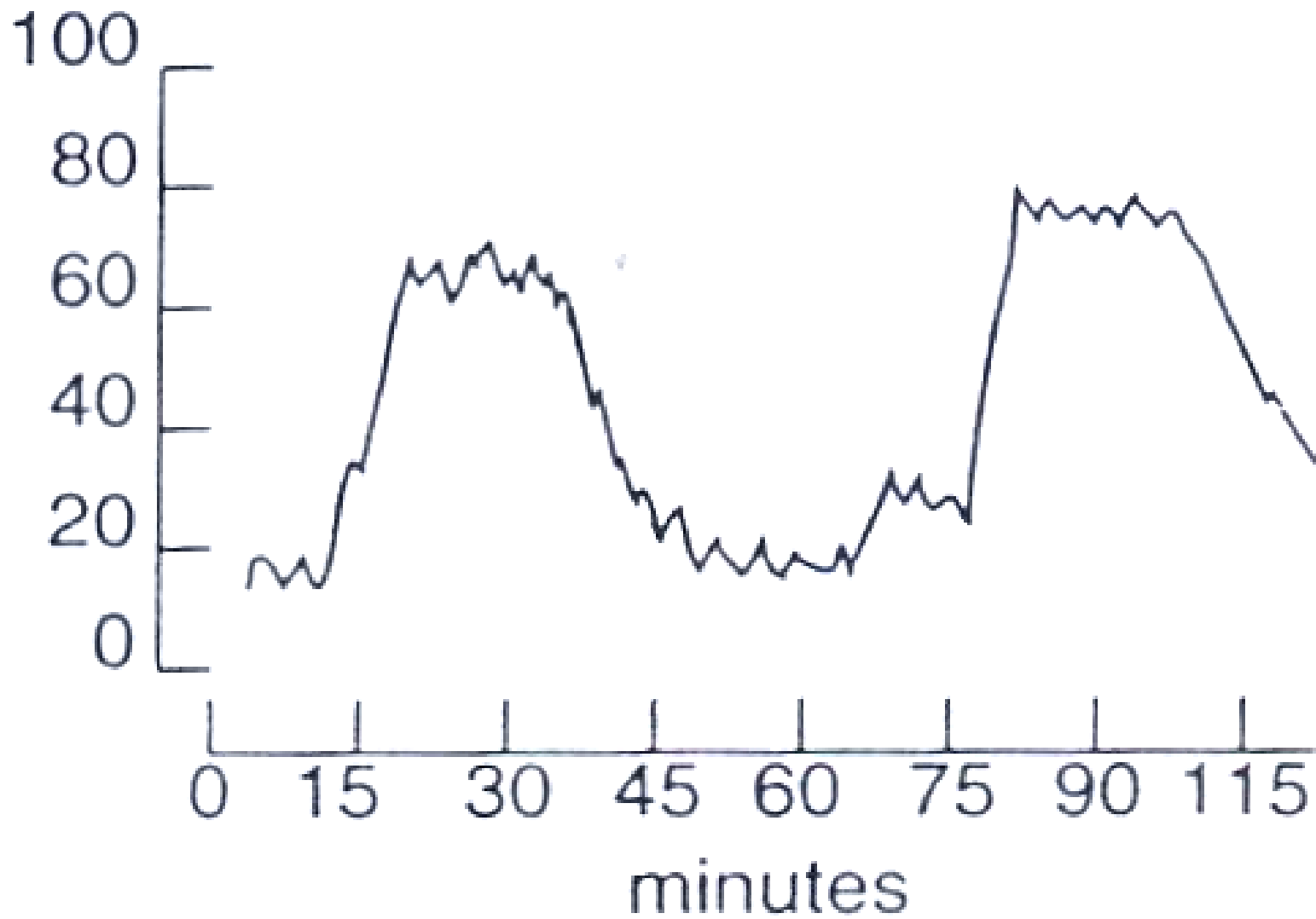


Figure 24-4 Plateau waves (Lundberg A waves)

Normal Function of IVC System

- Wave form
- Pulsation
- Output
- Lowering of Head of Bed increases ICP.
Bilateral JV pressure increases ICP

IVC Problems

- Block
- Improper connection
- Change of position of head of bed
- Drip chamber fall

IVC Trouble Shooting

- IVC no longer works
- ICP wave form dampened

Adjuncts to ICP Monitoring

- Evoked potential
- SJO2
- TCD
- PET & SPECT

ICP Treatment Measures

- Guidelines
 - ICP treatment should be initiated for ICP >20-25mm Hg
- Options
 - Interpretation and treatment of ICP based on any threshold should be corroborated by frequent clinical examination and CPP data
 - CPP should be maintain ≥ 70 mm Hg

ICP Management Protocol

- Goals of therapy
 - Keep ICP $<20\text{mmHg}$ (Prevents plateau waves from compromising CBF and causing cerebral ischemia and or brain death)
 - CPP $>70\text{mmHg}$ (avoid hypotension)

Summary of measures to control IC-HTN*

Goals: keep ICP < 20 mm Hg, and CPP \geq 70 mm Hg

Step	Rationale
GENERAL MEASURES (should be utilized routinely)	
elevate HOB to 30-45°	reduces ICP by enhancing venous outflow, but also reduces mean carotid pressure → no net change in CBF
keep neck straight, avoid tight trach tape	constriction of jugular venous outflow increases ICP
avoid hypotension (SBP < 90 mm Hg)	<ul style="list-style-type: none"> • normalize intravascular volume • use pressors if needed
control hypertension if present	<ul style="list-style-type: none"> • nitroprusside if not tachycardic • beta-blocker if tachycardic (labetalol, esmolol...) • avoid overtreatment → hypotension
avoid hypoxia (pO ₂ < 60 mm Hg) (maintain airway and adequate oxygenation)	hypoxia may cause further ischemic brain injury
ventilate to normocarbina (pCO ₂ = 35-40 mm Hg)	avoid prophylactic hyperventilation (see page 659)
light sedation: codeine 30-60 mg IM q 4 hrs PRN	(same as heavy sedation, see below)
unenhanced head CT scan for ICP problems†	rule out surgical condition

- Surgical treatment
 - Any subdural or epidural hematoma larger than 1cm maximal thickness should be removed
 - Patient with contused brain with progressive deterioration should be removed.
 - De-compressive craniectomy should be considered for ICP not controlled medically.
- General care
 - Avoid Hypoxia $\text{PaO}_2 < 60\text{mmHg}$
 - Avoid Hypo tension $\text{SBP} \leq 90\text{mmHg}$

Specific Treatment

- Prophylaxis against stress ulcer
- Control fever
- Arterial line
- CVP line
- IV fluid –
 - NS +20Meqkcl/let.
 - Avoid hypotonic solution
 - Normalize intra vascular volume
 - Concept of running patient dry is obsolete
 - If injury to other system present they may dictate Fluid management
 - Pressors or preferable to IV fluid bolus in head injury

Measures to Lower ICP

- General Measure
- Specific measures

Second Tier Therapy for Persistent IC Hyper Tension

- High dose Barbiturate therapy if ICP > 20-25 mmHg
- Hyper ventilation
- Hypothermia
- De-compressive craniectomy
- Lumber drainage
- Hypertensive therapy

Adjunctive Measures

- Lidocaine – 1.5 mg/kg IVP
- High frequency (Jet) ventilation

High Dose Barbiturate Therapy

- Guidelines
 - May be considered in hemodynamically stable salvageable severe TBI patient with Intra cranial Hypertension refractory to maximal Medical and surgical ICP lowering therapy
 - Theoretical benefits of barbiturates in head injury is derived from
 1. vasoconstriction in normal areas (shunting blood to ischemic brain tissue)
 2. Decreased metabolic demand for oxygen ($CMRO_2$) with accompanying reduction of CBF.
 3. Free radical scavenging
 4. Reduced intra cellular calcium
 5. Lysosomal stabilization

- Pentobarbital is choice

Load 10mg/kg/hr for 4 hrs.

1hr. 2.5mg/kg every 15 min.

four doses

Next 3hrs. 10mg/kg /hr infusion

Maintain 1.5mg/kg/hr infusion

BSAER early. Repeat if Pentobarbital level >6mg%

Goal ICP <24mmHg level 3-5mg%

If ICP <20 mmHg continue treatment for 48hrs. And then Taper dose

THANK YOU