

# Verhoogde intracraniële druk

Ruben Dammers

Neurochirurg

Erasmus MC & Kinderziekenhuis

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Under pressure  
WES-regio Rotterdam

# Indeling

- Fysiologie ICP
  - Normaalwaarden
  - Cerebrale perfusiedruk
  - Monro-Kellie hypothese
  - Volumecompensatie en –buffering
  - Volume/drukrelatie
- Verhoogde ICP
  - Definitie en registratie
  - Oorzaken
  - Klinische verschijnselen
  - Behandeling

# Indeling

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# Fysiologie ICP

- ICP = intracranial pressure (intracraniële druk)
- Normaalwaarden:

	Gemiddelde (cmH <sub>2</sub> O)	Standaarddeviatie
	<i>1 cmH<sub>2</sub>O = 0,736 mmHg</i>	
Neonaat	3,5	5
Jong kind (ca. 10 jaar)	8	5
Ouder kind en volwassene	15,5	5

## Cerebrale perfusiedruk (CPP)

- CPP geeft informatie over de cerebrale bloeddorstrooming (CBF) en is te berekenen via:

$$\text{CPP (cerebrale perfusiedruk)} = \text{MAP} - \text{ICP}$$

$$\text{CBF} = \text{CPP} / \text{CVR}$$

- Fysiologische CBF: ca 50 mL/100 g/min
  - 750 cc/min (15-20% cardiac output)
- Door cerebrale autoregulatie is de CBF pas in gevaar bij een CPP < 50 mmHg
- CPP is even belangrijk als ICP, zo niet belangrijker

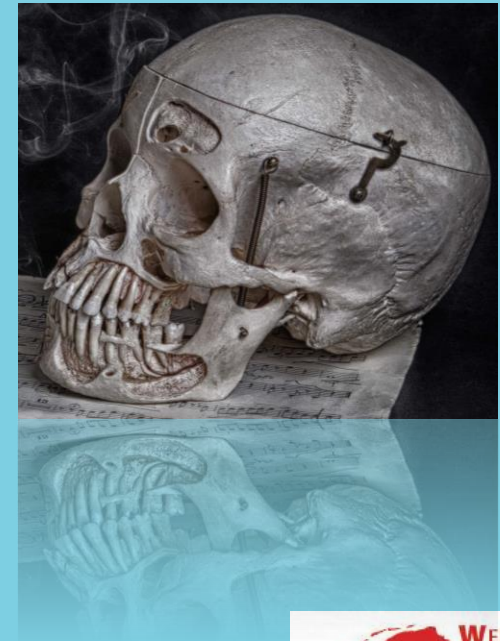


# Monro-Kellie hypothese

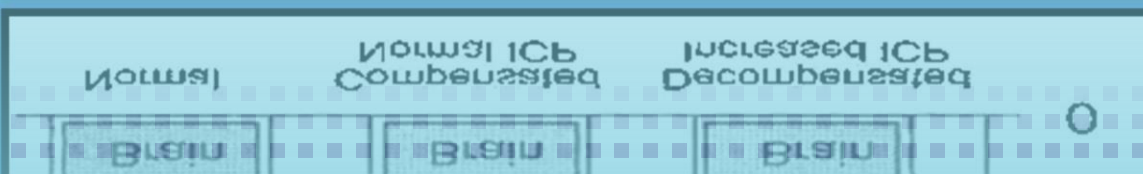
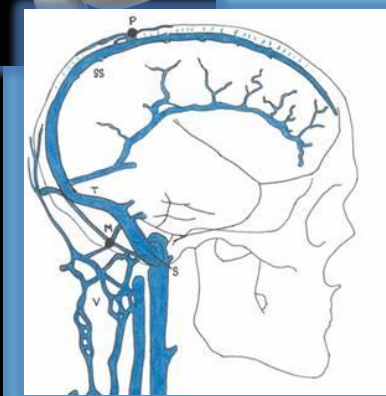
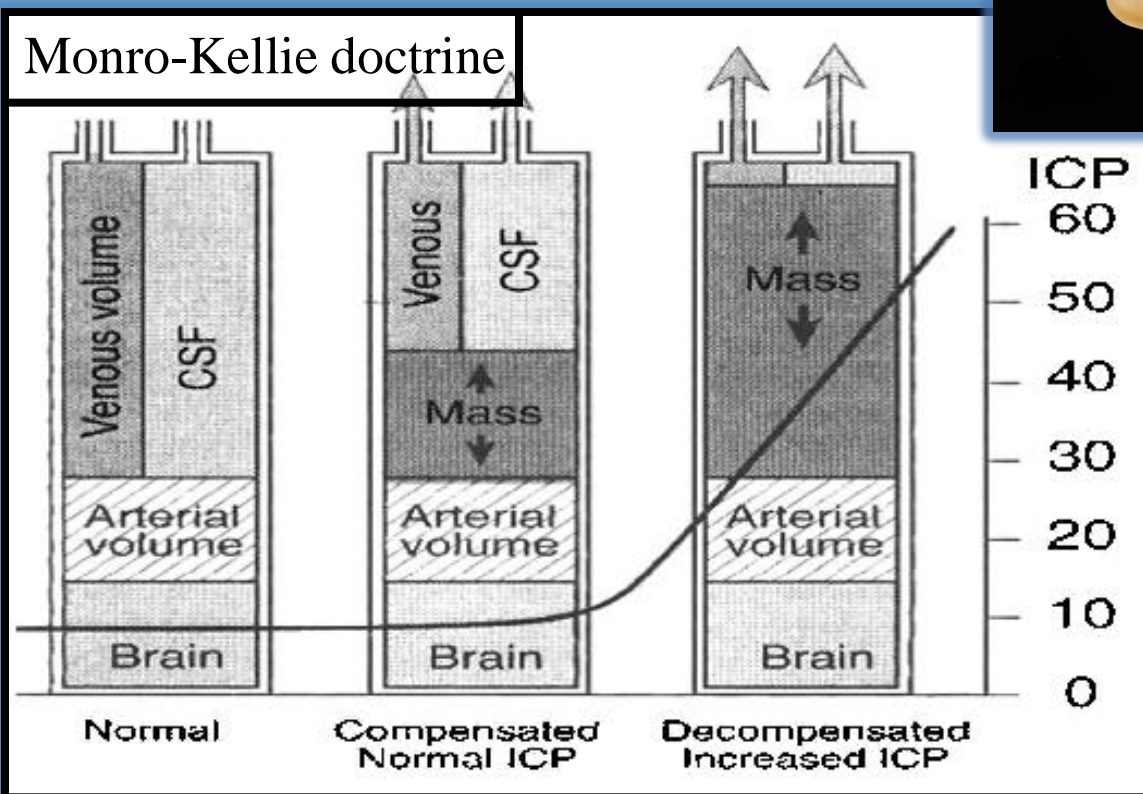
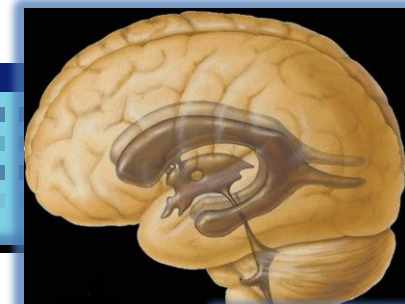
- Monro-Kellie hypothese

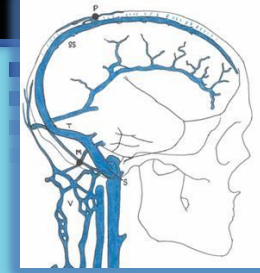
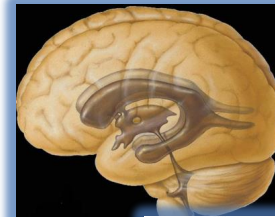
$$V_{\text{schedel}} = V_{\text{brein}} + V_{\text{liquor}} + V_{\text{intravasaal bloed}} + V_{\text{RIP}}$$

- Schedelvolumen blijft i.p. constant ( $\approx 1700$  mL)
- Schedel inelastisch  $\rightarrow$  ICP-stijging



# Monro-Kellie hypothese





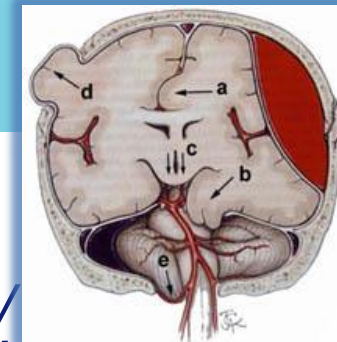
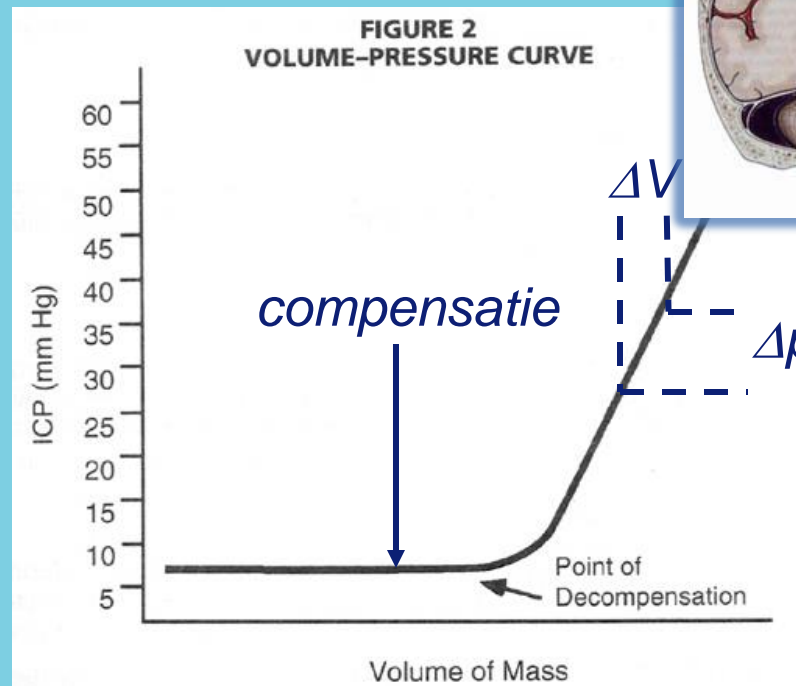
# Fysiologie ICP

- Volumecompensatie
  - Door:
    - Compressie veneuze structuren → verhoogde bloedafvoer en afname intracraniële bloedvolume
    - Liquorresorptie neemt toe bij verhoogde druk
    - Verschuiving liquor naar wervelkanaalcompartiment
  - Afhankelijk van de snelheid van volumetoename
- Volumebuffering
  - Elasticiteit van cerebrum en bloedvaten



# Fysiologie ICP

- Door volumeverandering ( $\Delta V$ ) treedt drukverandering ( $\Delta p$ ) op
- Compliantie =  $\Delta V / \Delta p$

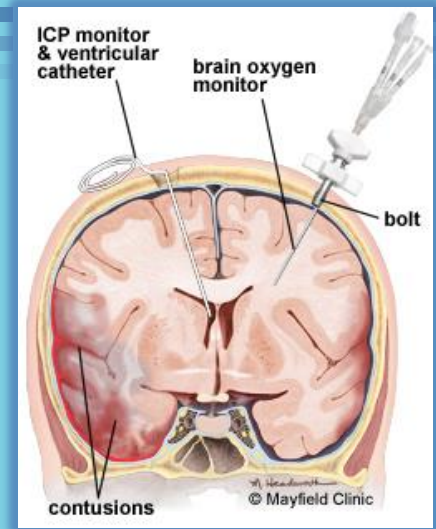
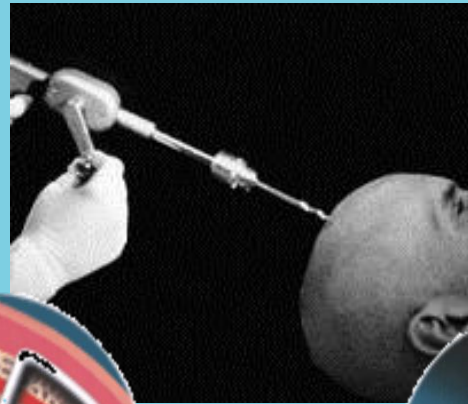


# Indeling

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# Verhoogde ICP

- ICP > gemiddelde + 2SD
  - 20-25 mmHg



# Brain Trauma Foundation

## VIII. Intracranial Pressure Thresholds

### *A. Level I*

There are insufficient data to support a Level I recommendation for this topic.

### *B. Level II*

Treatment should be initiated with intracranial pressure (ICP) thresholds above 20 mm Hg.

### *C. Level III*

A combination of ICP values, and clinical and brain CT findings, should be used to determine the need for treatment.

## IX. Cerebral Perfusion Thresholds

### A. Level I

There are insufficient data to support a Level I recommendation for this topic.

### B. Level II

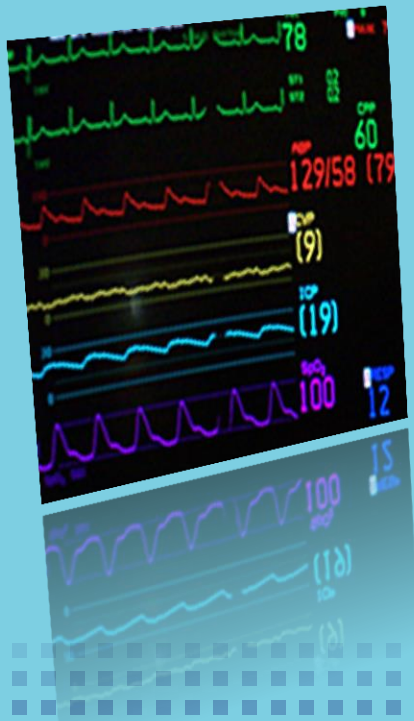
Aggressive attempts to maintain cerebral perfusion pressure (CPP) above 70 mm Hg with fluids and pressors should be avoided because of the risk of adult respiratory distress syndrome (ARDS).

### C. Level III

CPP of <50 mm Hg should be avoided.

The CPP value to target lies within the range of 50–70 mm Hg. Patients with intact pressure autoregulation tolerate higher CPP values.

Ancillary monitoring of cerebral parameters that include blood flow, oxygenation, or metabolism facilitates CPP management.



*ICP monitors, per se, do not save lives. The people who judiciously use the data obtained from ICP monitoring can save lives and alter outcomes in patients with severe head injuries*

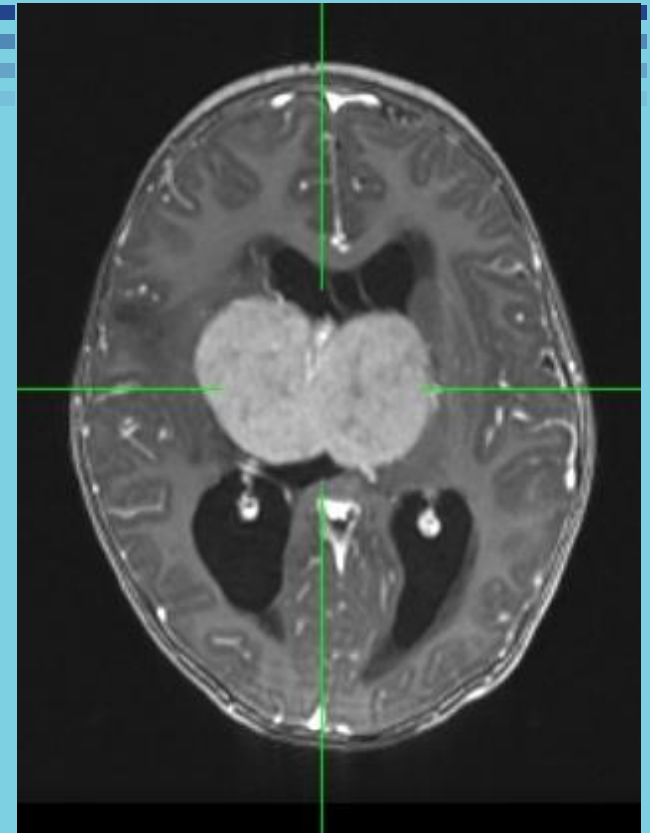
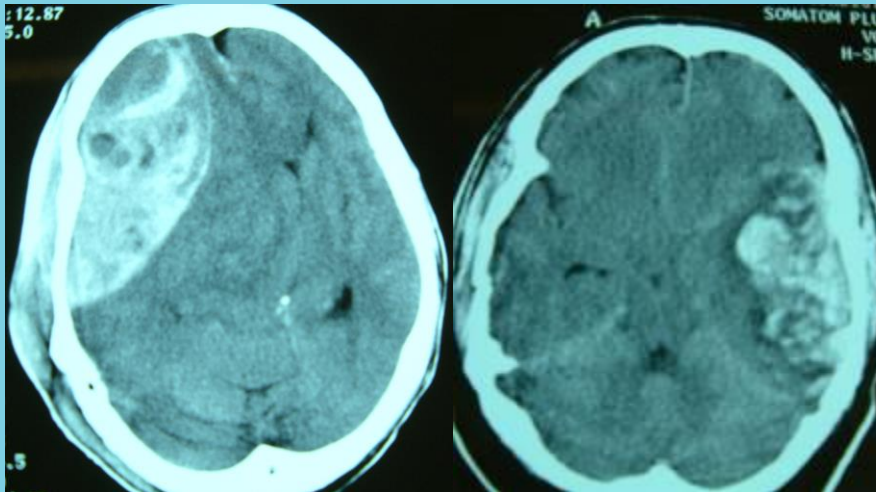
T.G. Saul, T.B. Ducker, 1982

## Oorzaken verhoogde ICP

- Massa effect
- Gegeneraliseerde hersenzwelling
- Verhoogde veneuze druk
- Hydrocephalus (obstructief / communicatief)
- Verhoogde liquorproductie
- Craniosynostosis

## Oorzaken verhoogde ICP

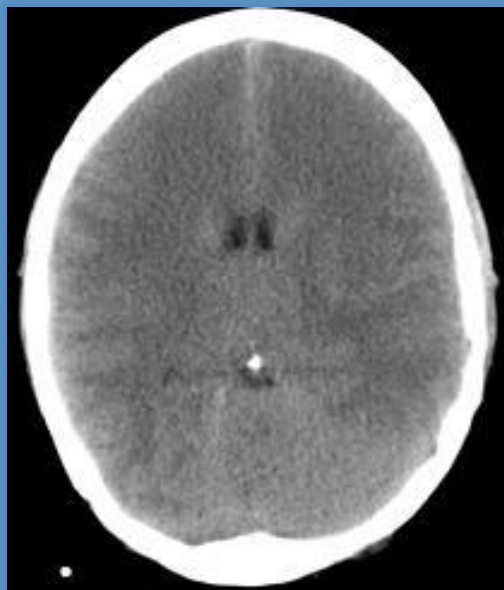
- Massa effect
  - Tumor
  - Infarct
  - Hematoom
  - contusie





## Oorzaken verhoogde ICP

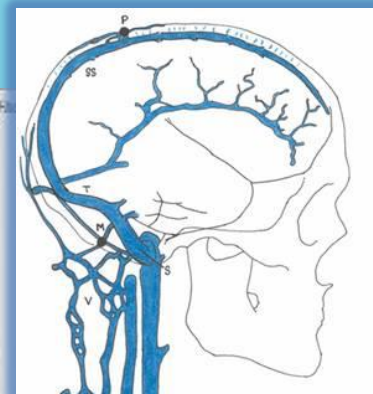
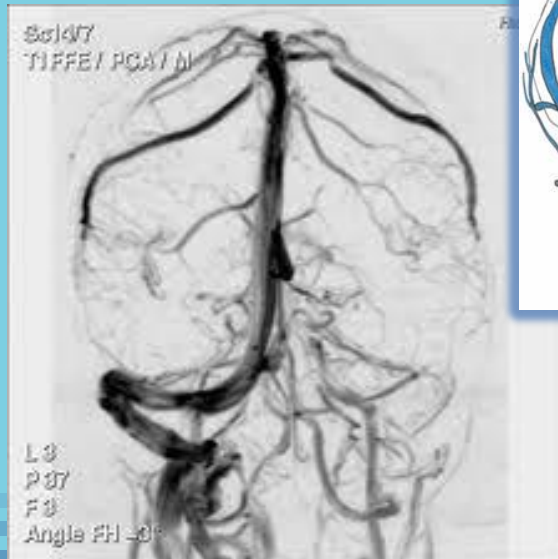
- Massa effect
- Gegeneraliseerde hersenzwelling
  - Ischemie – anoxie na AMI
  - Encephalopathie (leverfalen, hypertensie)



*Hyponatriemie*

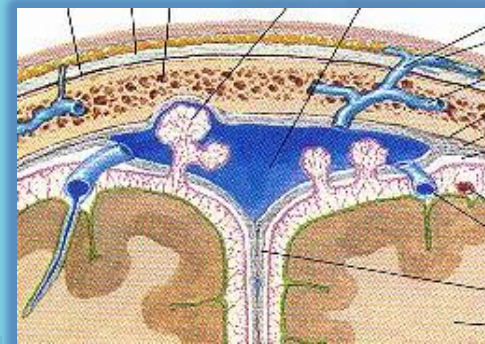
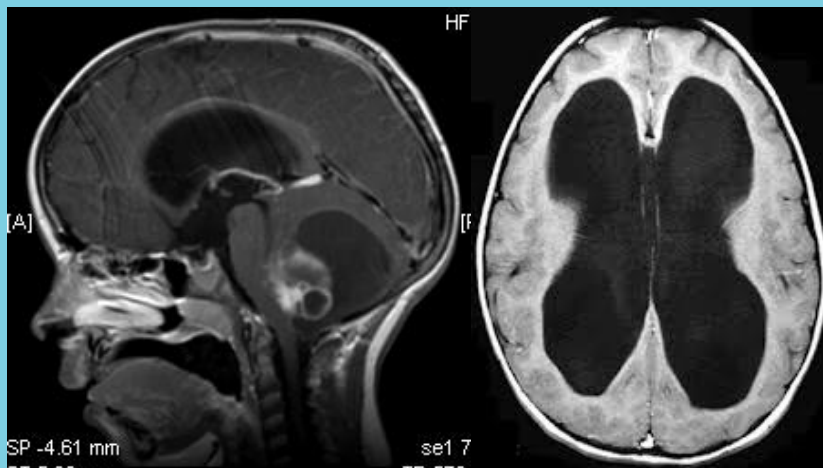
# Oorzaken verhoogde ICP

- Massa effect
- Gegeneraliseerde hersenzwelling
- Verhoogde veneuze druk
  - Sinusthrombose
  - Hartfalen



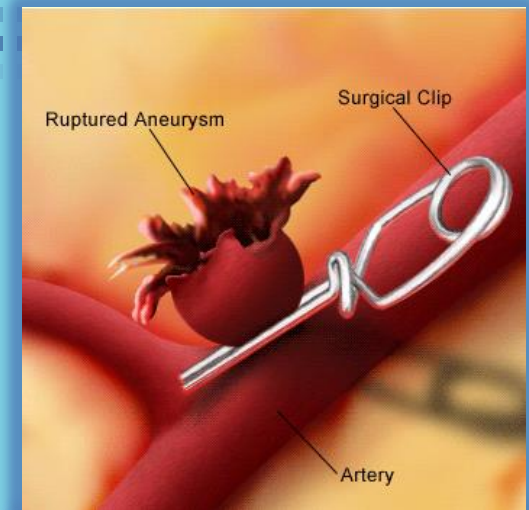
## Oorzaken verhoogde ICP

- Massa effect
- Gegeneraliseerde hersenzwelling
- Verhoogde veneuze druk
- Hydrocephalus (obstructief / communicatief)
  - Massa in liquorsysteem
  - Leptomeningeale aandoening (infectie, meta, bloeding)



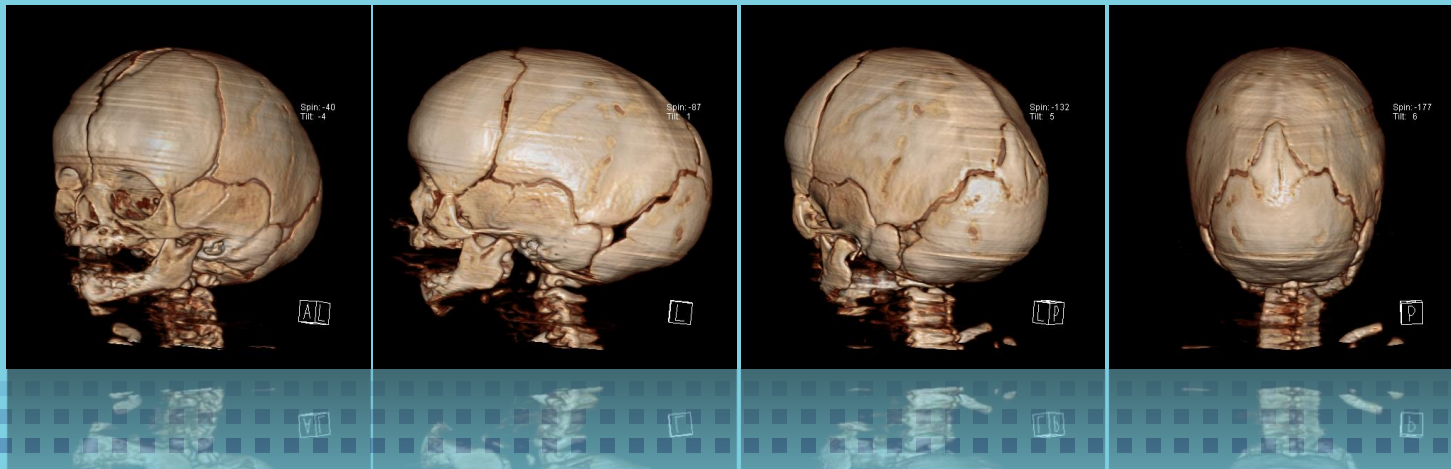
# Oorzaken verhoogde ICP

- Massa effect
- Gegeneraliseerde hersenzwelling
- Verhoogde veneuze druk
- Hydrocephalus (obstructief / communicatief)
- Verhoogde liquorproductie
  - Plexustumor
  - Meningitis
  - SAB



# Oorzaken verhoogde ICP

- Massa effect
- Gegeneraliseerde hersenzwelling
- Verhoogde veneuze druk
- Hydrocephalus (obstructief / communicatief)
- Verhoogde liquorproductie
- **Craniosynostosis**



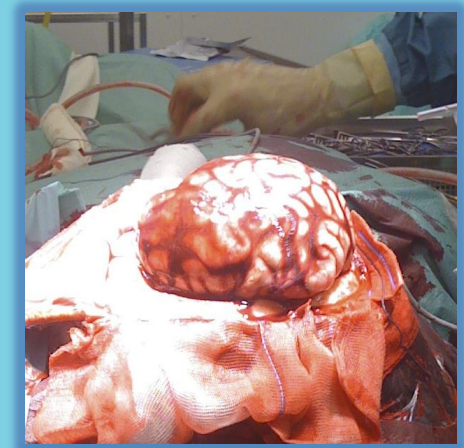
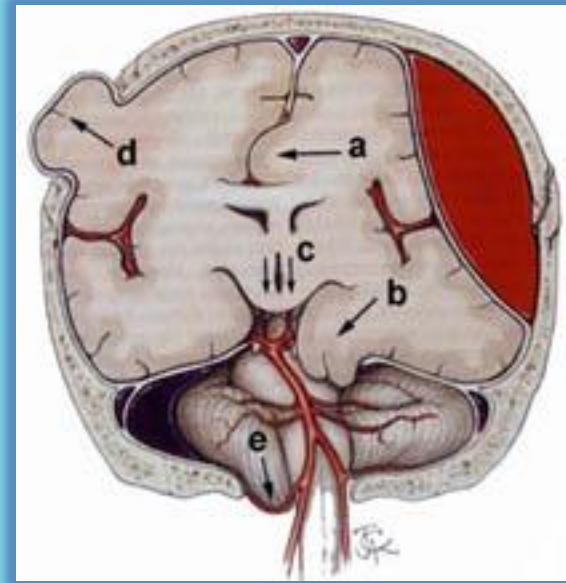
## Klinische verschijnselen verhoogde ICP

- Klinische verschijnselen:
  - Hoofdpijn
  - Misselijkheid, met of zonder braken
  - Gedaald bewustzijn (EMV-score)
  - Trias van Cushing (= hypertensie, bradycardie en irregulaire ademhaling)
  - Pupilreacties (Cave inklemming!!!)
  - Papiloedeem bij fundoscopie
  - Neonaten: sunset fenomeen, gespannen fontanel, toegenomen schedelomtrek

## Klinische verschijnselen verhoogde ICP

	<i>15-point scale (Teasdale and Jennett, 1976)</i>		<i>Pediatric scale (Simpson and Reilly, 1982)</i>	
Eye opening	Spontaneous	4	The same	
	To sound	3		
	To pain	2		
	None	1		
Best verbal response	Orientated	5	Orientated	5
	Confused	4	Words	4
	Inappropriate	3	Vocal sounds	3
	Incomprehensible	2	Cries	2
	None	1	None	1
Best motor response	Obeys commands	6	Obeys commands	5
	Localizes pain	5	Localizes pain	4
	Flexion-withdrawal	4	Flexion	3
	Flexion-abnormal	3	Extension	2
	Extension	2	None	1
	None	1		
Maximum sum	15		14	

# Klinische verschijnselen verhoogde ICP



*Bradycardie, hypertensie, irregulaire ademhaling*



# Klinische verschijnselen verhoogde ICP



## TENTORIAL HERNIATION – Lateral

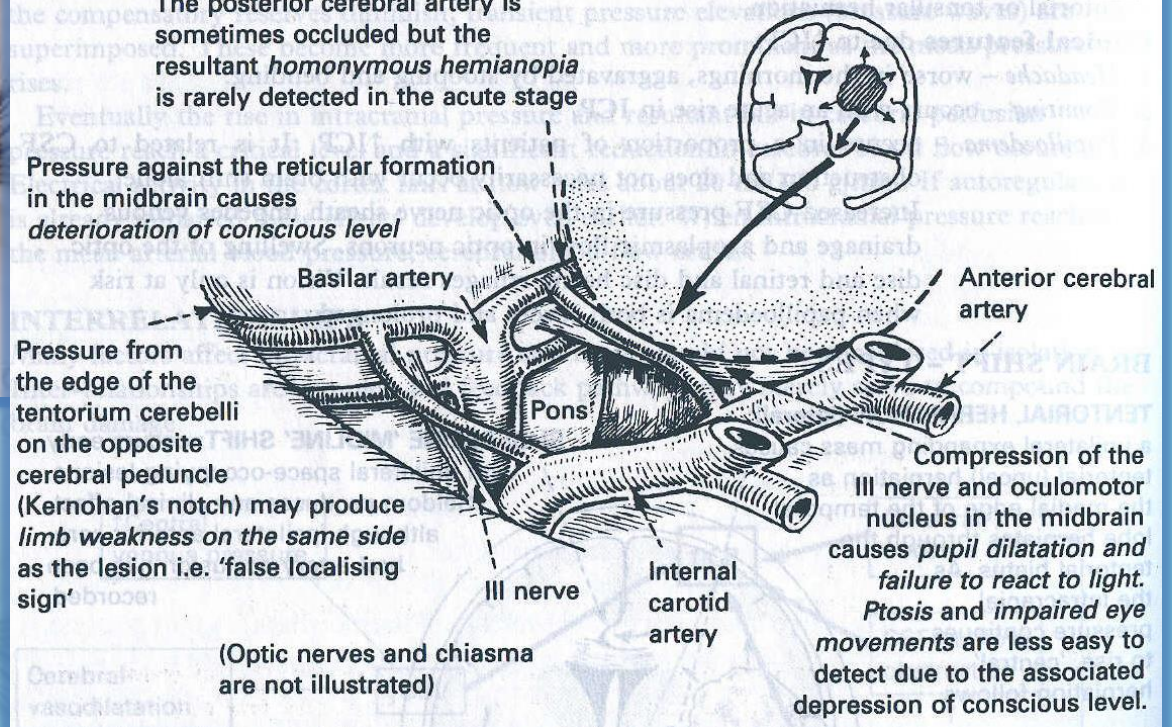
The posterior cerebral artery is sometimes occluded but the resultant *homonymous hemianopia* is rarely detected in the acute stage

Pressure against the reticular formation in the midbrain causes *deterioration of conscious level*

Pressure from the edge of the tentorium cerebelli on the opposite cerebral peduncle (Kernohan's notch) may produce *limb weakness on the same side as the lesion* i.e. 'false localising sign'

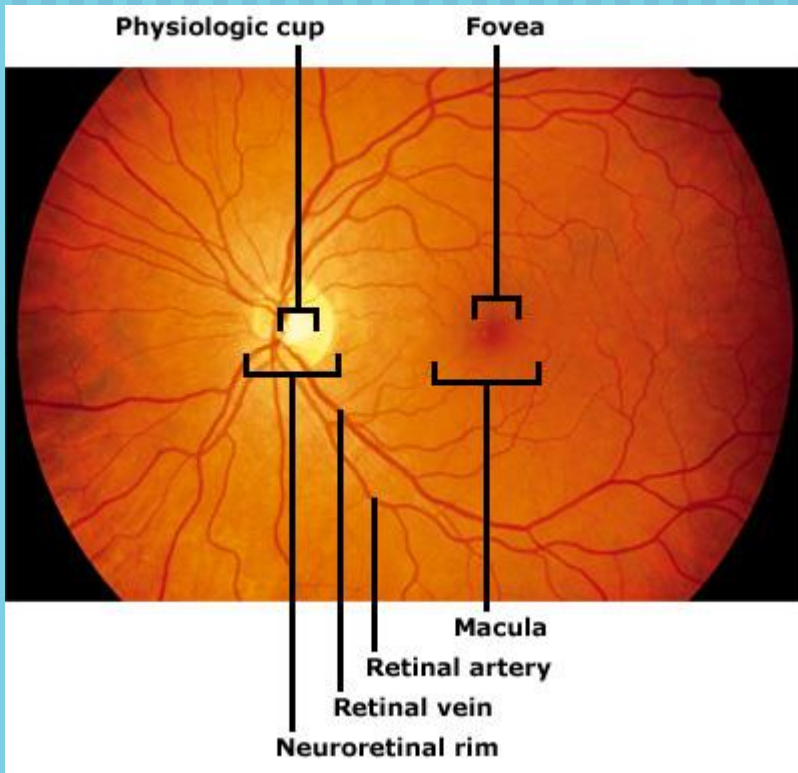
(Optic nerves and chiasma are not illustrated)

The rate of symptom progression is related to the rate of lesion expansion.



Compression of the III nerve and oculomotor nucleus in the midbrain causes *pupil dilatation and failure to react to light*. *Ptosis and impaired eye movements* are less easy to detect due to the associated depression of conscious level.

# Klinische verschijnselen verhoogde ICP



## Behandeling verhoogde ICP

- Positioneren (hoofd in middellijn, 30° omhoog)
- Evt. onderliggende aandoening behandelen (pe meningitis, tumor)
- Sedatie, Pijnbestrijding
- Opereren
- Liquordrainage
- Mannitol / hypertoon zout
- Hyperventileren
- Barbituraten
- (Steroiden)
- Decompressieve craniectomie
- (Hypothermie)

## XI. Anesthetics, Analgesics, and Sedatives

### A. Level I

There are insufficient data to support a Level I recommendation for this topic.

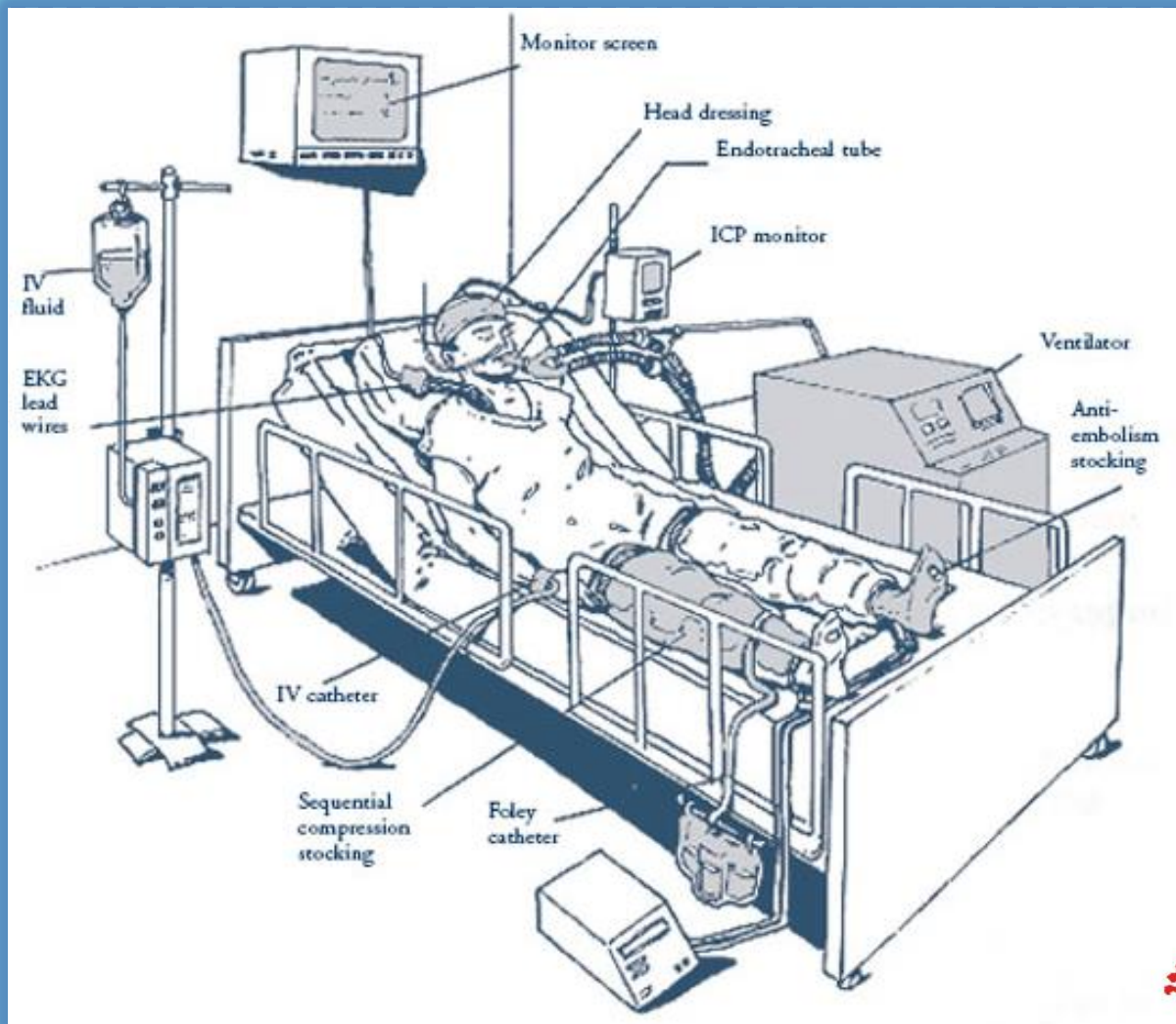
### B. Level II

Prophylactic administration of barbiturates to induce burst suppression EEG is not recommended.

High-dose barbiturate administration is recommended to control elevated ICP refractory to maximum standard medical and surgical treatment. Hemodynamic stability is essential before and during barbiturate therapy.

Propofol is recommended for the control of ICP, but not for improvement in mortality or 6 month outcome. High-dose propofol can produce significant morbidity.

# Positionering!!!



## XIV. Hyperventilation

### A. Level I

There are insufficient data to support a Level I recommendation for this topic.

### B. Level II

Prophylactic hyperventilation (PaCO<sub>2</sub> of 25 mm Hg or less) is not recommended.

### C. Level III

Hyperventilation is recommended as a temporizing measure for the reduction of elevated intracranial pressure (ICP).

Hyperventilation should be avoided during the first 24 hours after injury when cerebral blood flow (CBF) is often critically reduced.

If hyperventilation is used, jugular venous oxygen saturation (SjO<sub>2</sub>) or brain tissue oxygen tension (PbrO<sub>2</sub>) measurements are recommended to monitor oxygen delivery.

## II. Hyperosmolar Therapy

### A. Level I

There are insufficient data to support a Level I recommendation for this topic.

### B. Level II

Mannitol is effective for control of raised intracranial pressure (ICP) at doses of 0.25 gm/kg to 1 g/kg body weight. Arterial hypotension (systolic blood pressure < 90 mm Hg) should be avoided.

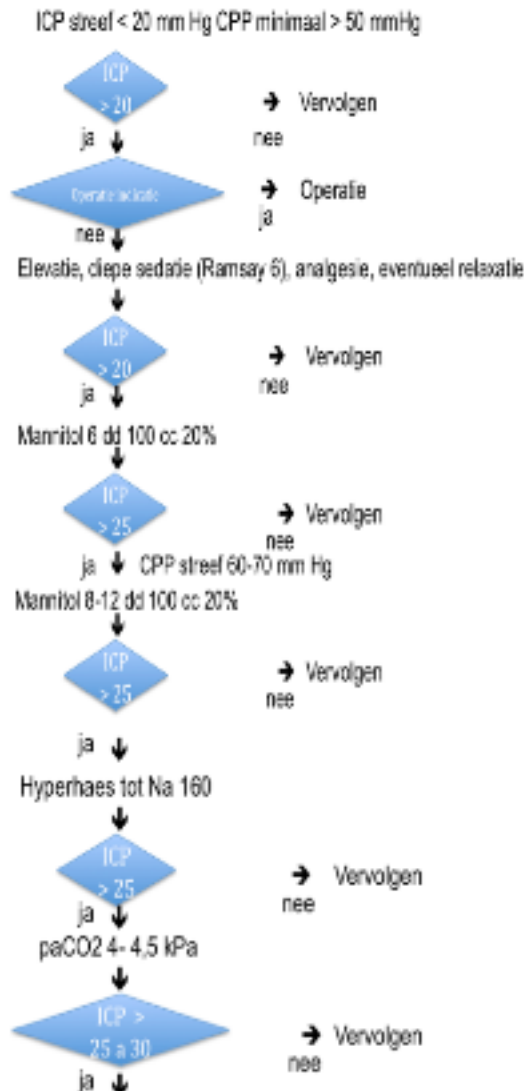
### C. Level III

Restrict mannitol use prior to ICP monitoring to patients with signs of transtentorial herniation or progressive neurological deterioration not attributable to extracranial causes.



# Guidelines for the Surgical Management of Traumatic Brain Injury





Barbituralen  
Decompressieve craniotomie  
Liquordrainage

## Behandelvoorwaarden

Hypoxie altijd voorkomen streef SpaO2 95 -100%

Hypotensie altijd voorkomen, systole minimaal 110 mm Hg

Vanaf stap Mannitol 8 dd: CPP in principe 60-70 mm Hg

In principe normocapnie, hypercapnie voorkomen, overweeg korte hyperventilatie bij Plateau drukgolven

Streef normothermie, indien hypothermie bij binnenkomst niet actief opwarmen boven 35 °C

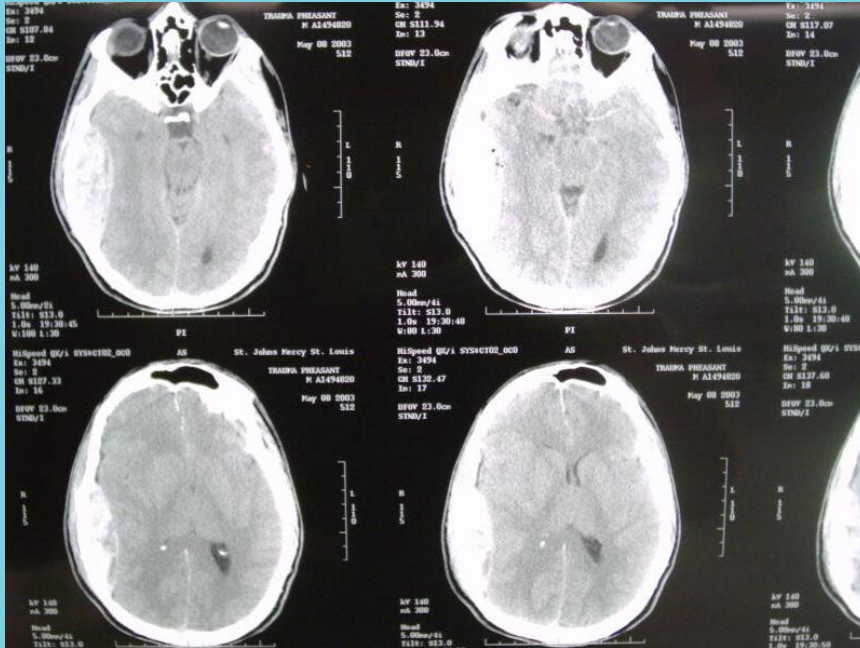
Hb minimaal 5 mmol/l

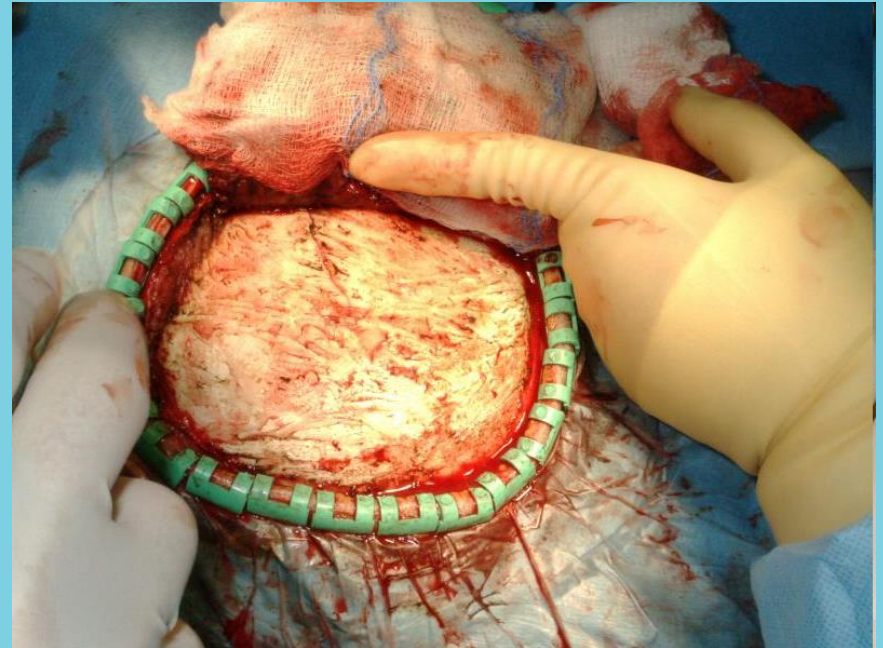
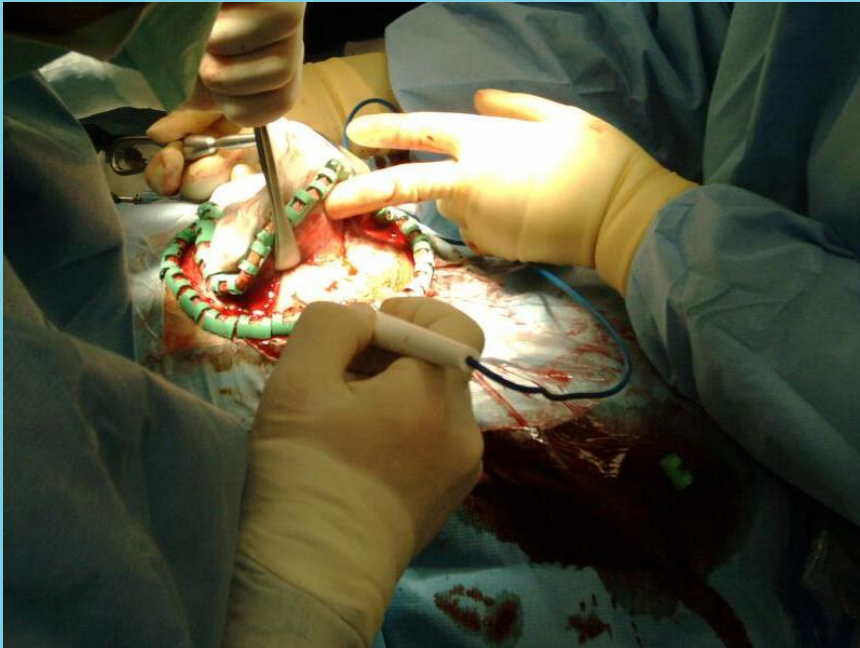
In acute fase regelmatig controle stolling (DIS pakket)

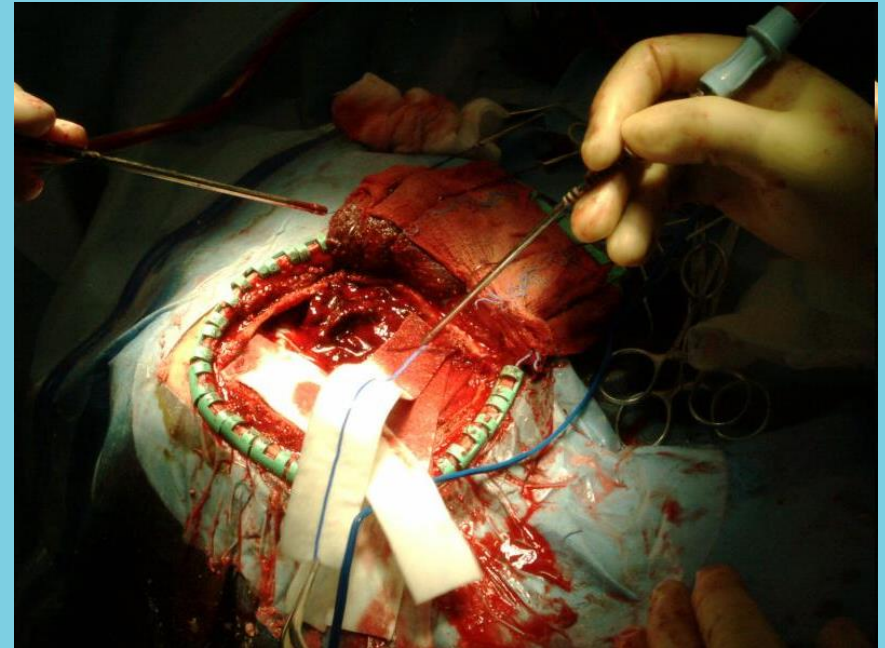
Streef naar  
thrombocyten >100 \* 10<sup>9</sup>/l  
APTT INR <1,4  
PT INR <1,4  
Fibrinogeen >1 g/l

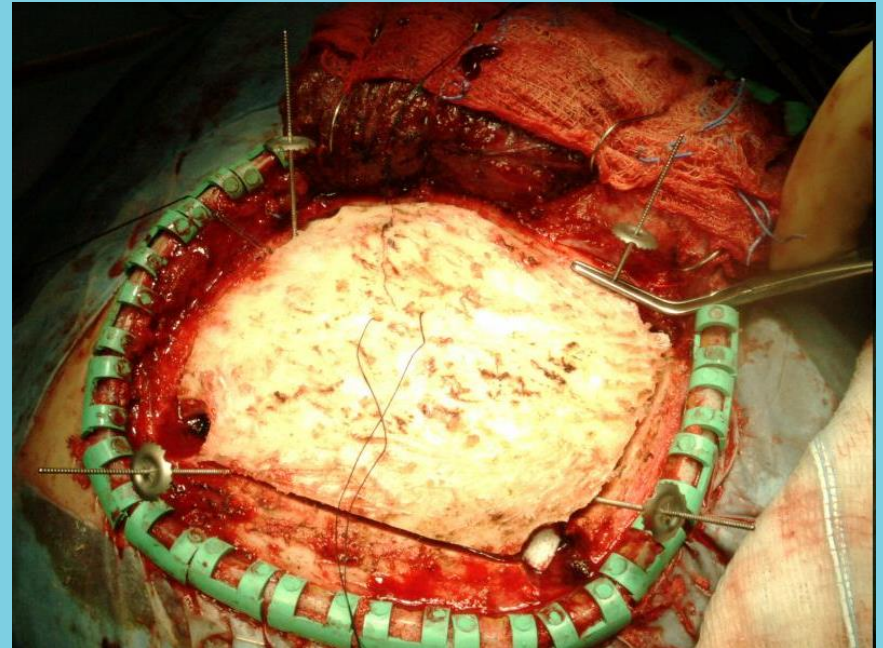
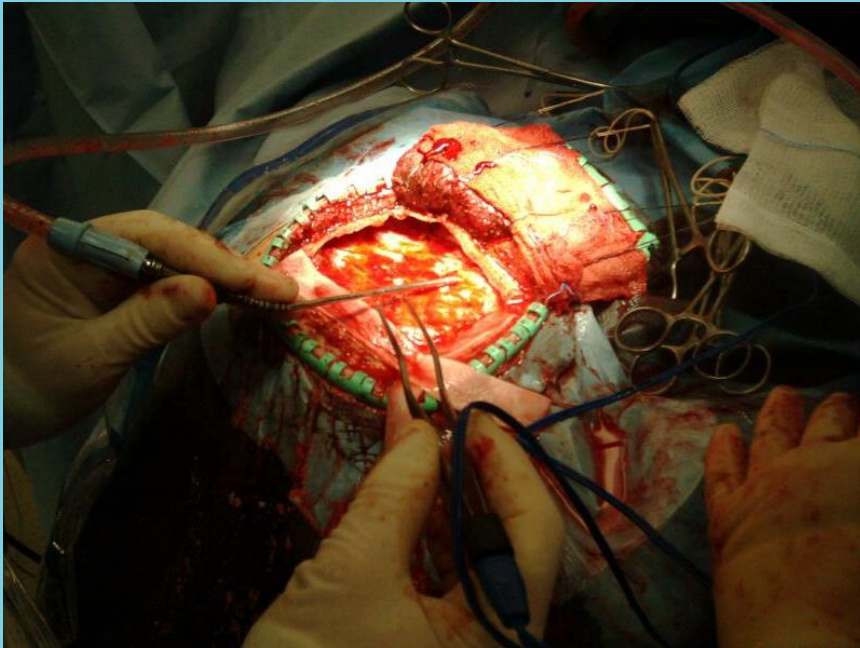
Bij relatief wijde ventrikels eerder EVD overwegen

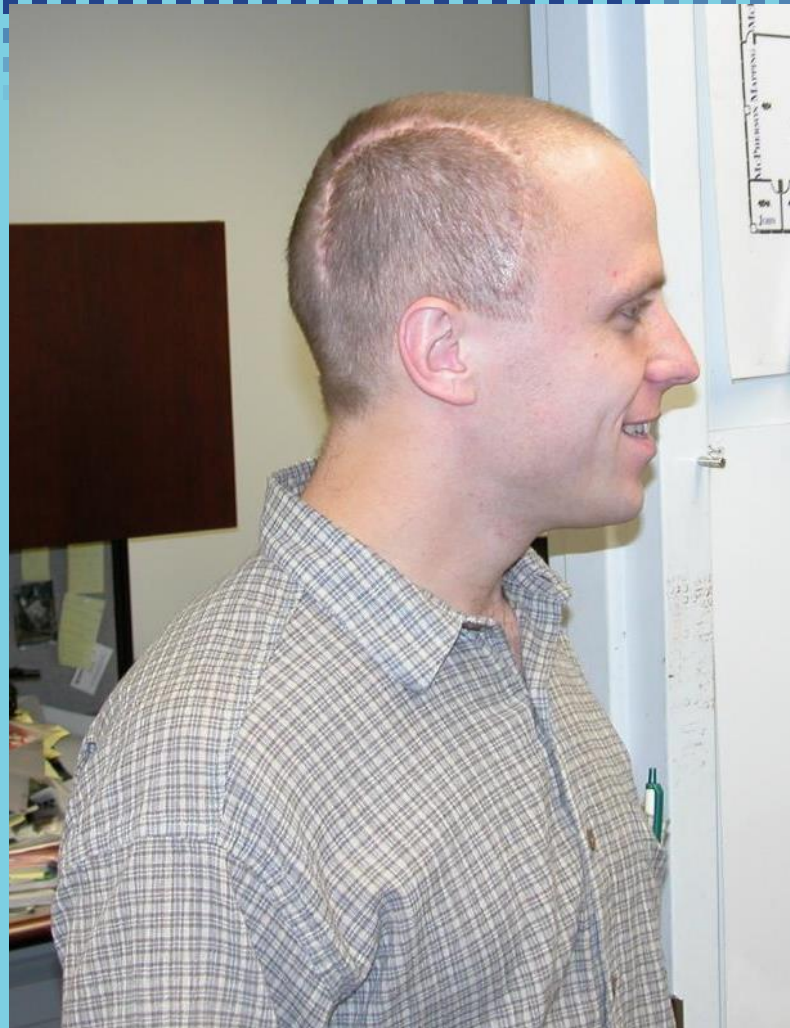
# Operatie (epiduraal hematoom)



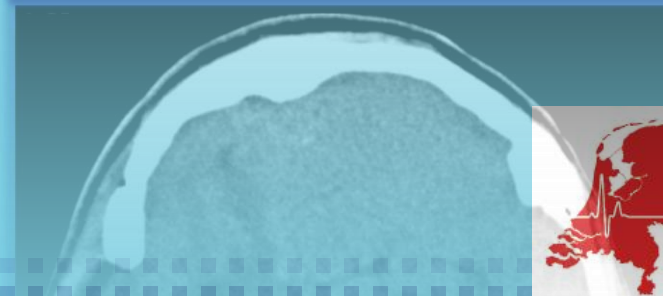
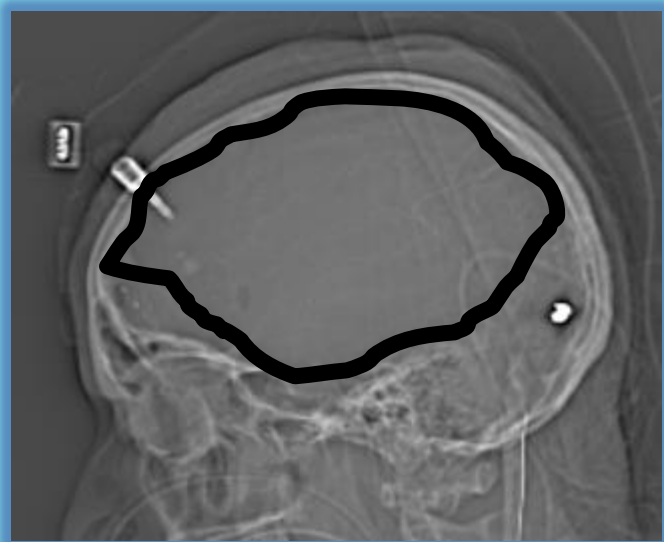








# Decompressieve craniectomie



# Primair hersenletsel

## Voorkomen is beter dan genezen

"I DON'T LIKE WEARING A **HELMET**

(LONGU LI - HEAD SURGERY PATIENT)

IT RUINS MY HAIR"



EVERY YEAR OVER 11,000 PEOPLE DIE ON OUR ROADS AND 30,000 ARE SERIOUSLY INJURED. THAT MEANS THOUSANDS OF FAMILIES LEFT PICKING UP THE PIECES. FAMILIES TORTURED BY THE LOSS OF A LOVED ONE CRIPPLED BY REDUCED INCOME OR THE SUDDEN NEED TO CARE FOR A RELATIVE WITH PERMANENT BRAIN DAMAGE. THE SAD TRUTH IS THAT 40% OF THESE CASES COULD HAVE BEEN PREVENTED BY SIMPLY WEARING A HELMET. WHEN YOU THINK ABOUT IT, THERE ARE NO EXCUSES.



WEAR A HELMET. NOT JUST FOR YOUR!



# Vragen?



Vragen?  
Opmerkingen