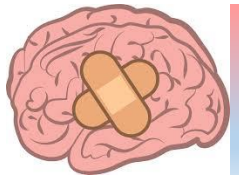
ROSGAYAH ABD MAJID

Hospital Wanita Kanak-Kanak Sabah

26th September 2018

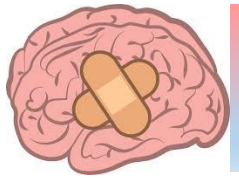
Acknowledgement

A courtesy to Dr Imtinaan for her slides



OUTLINES

- DEFINITION OF TBI
- EPIDEMIOLOGY
- ANATOMY
- PHYSIOLOGY
- PATHOPHYSIOLOGY
- CLASSIFICATION OF HEAD INJURY
- PAEDIATRIC TRAUMA
- SHAKEN BABY SYNDROME
- APPROACH AND MANAGEMENT TO TBI
- COMPLICATIONS
- CONTROVERSIAL ISSUES
- SUMMARY
- REFERENCES



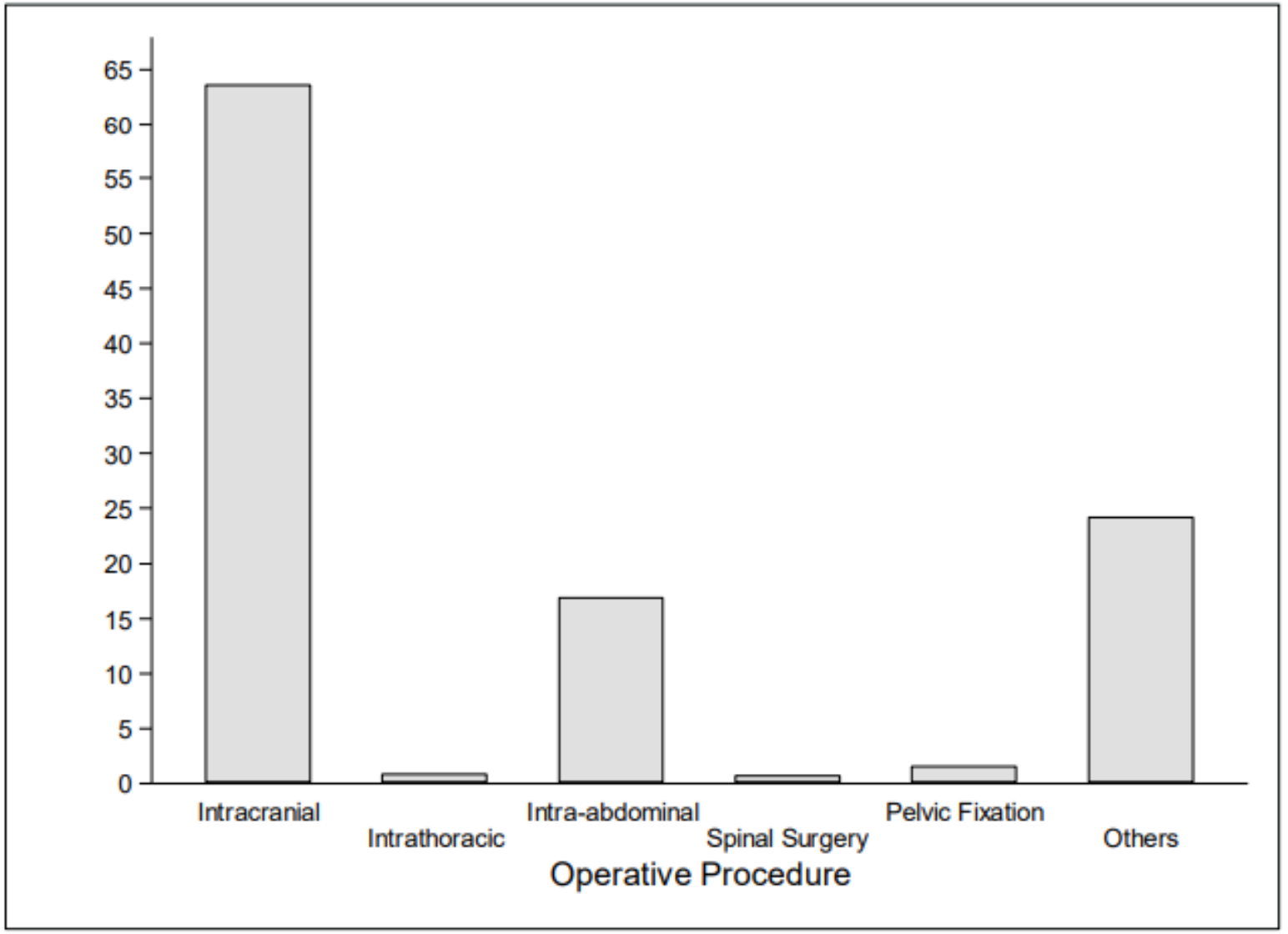
DEFINITION OF TBI

Non-degenerative, non-congenital insult to the brain from an external mechanical force, possibly leading to temporary or permanent impairment of cognitive, physical and psychosocial functions, with an associated diminished or altered state of consciousness

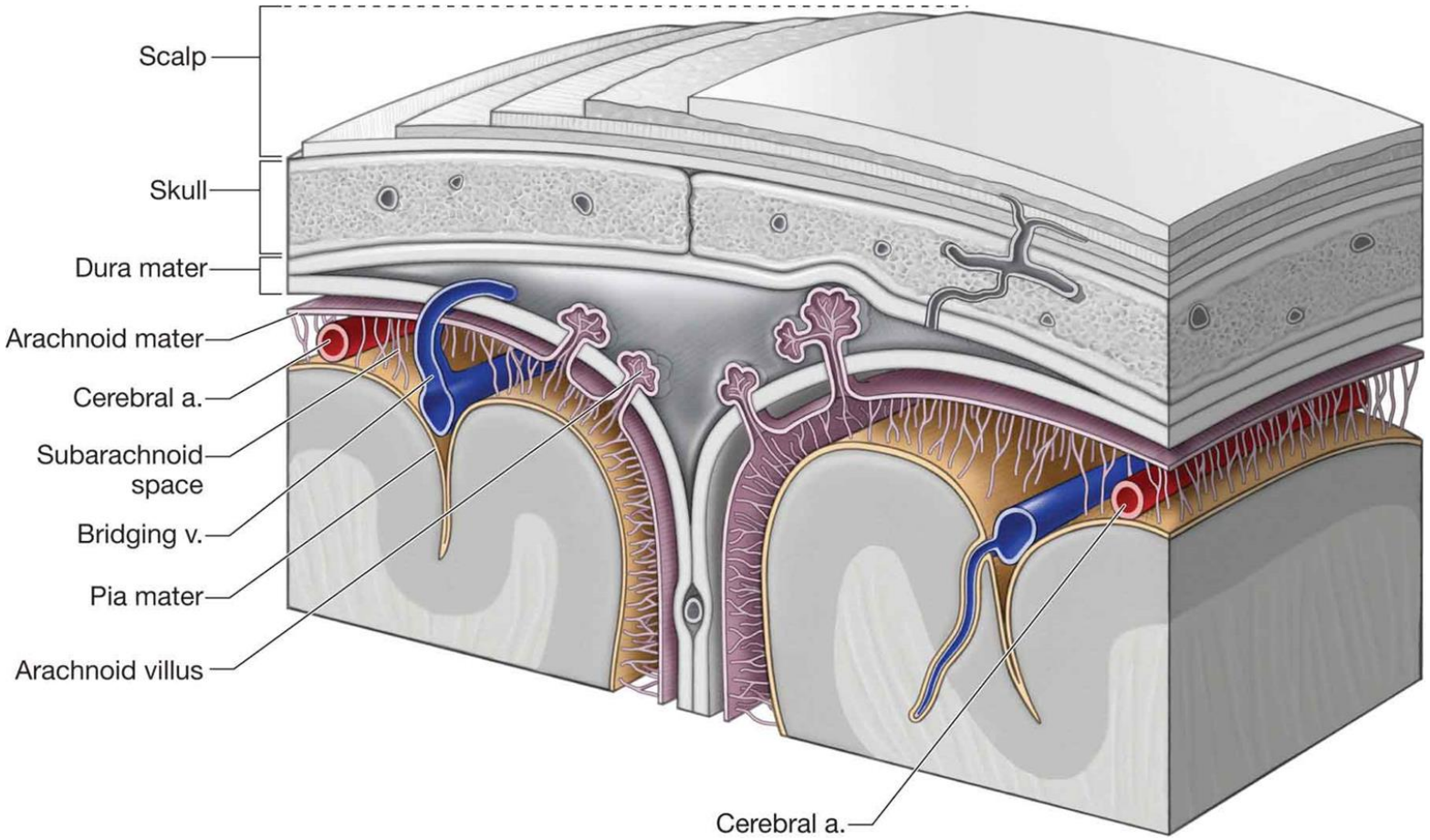
- CPG Early Management of Head Injury in Adults (2015

EPIDEMIOLOGY *(National Trauma Database 4th Edition, 2009)*

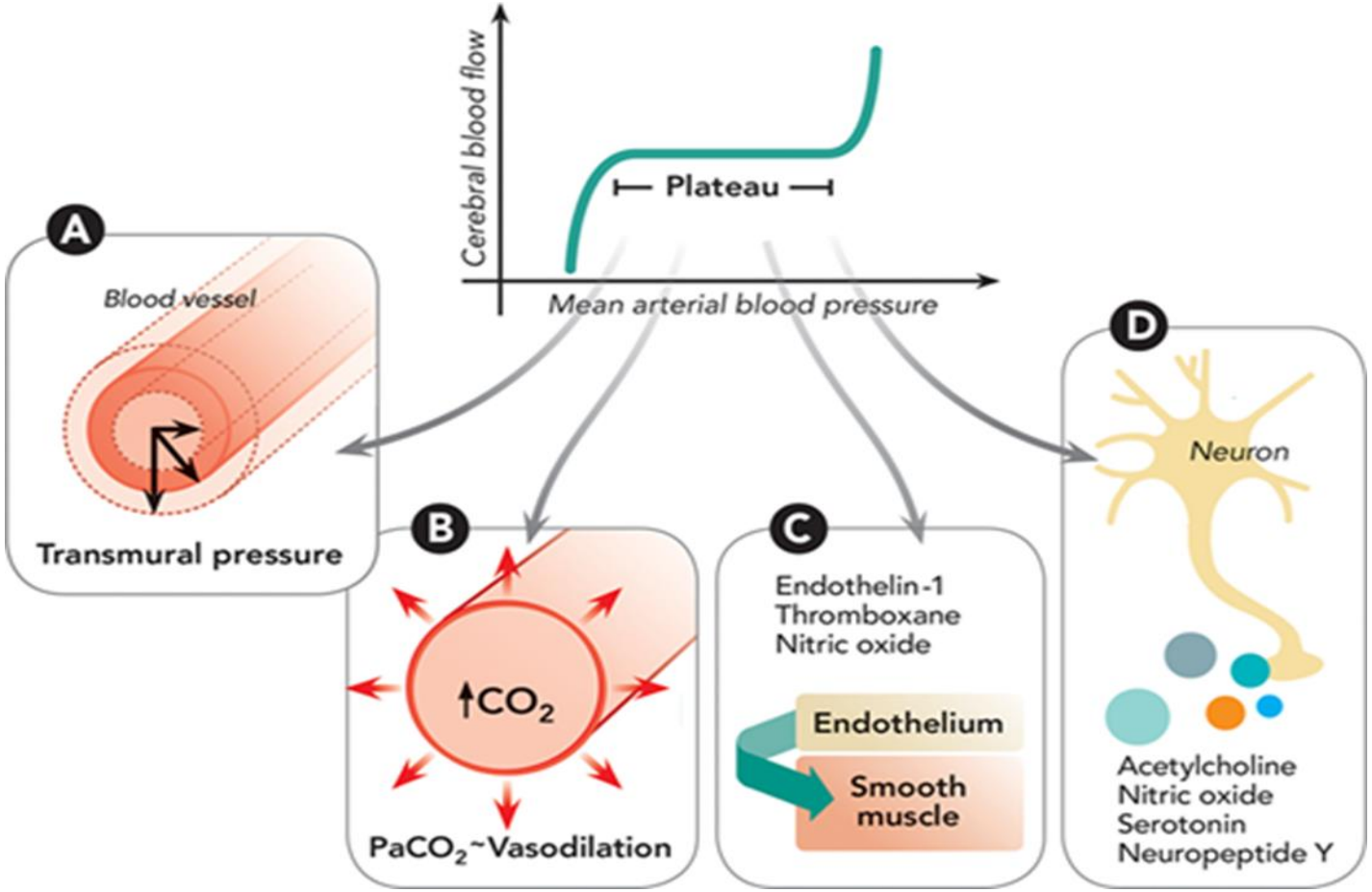
Figure 3.3. Operative Procedure for Major Trauma Cases

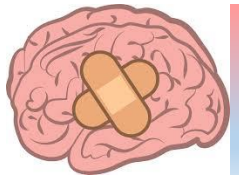


ANATOMY

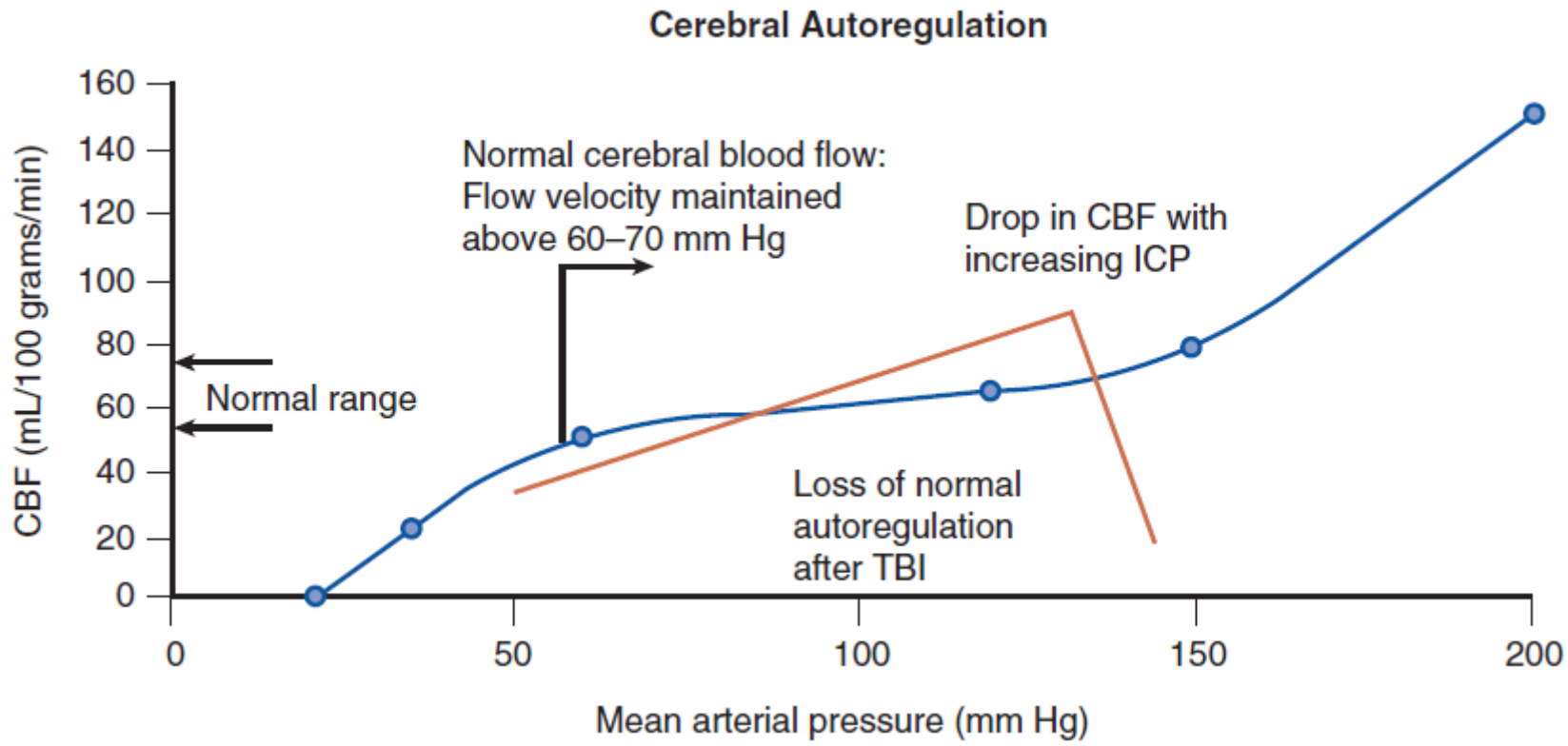

Scalp
Skull
Dura mater
Arachnoid mater
Cerebral a.
Subarachnoid space
Bridging v.
Pia mater
Arachnoid villus
Cerebral a.

PHYSIOLOGY

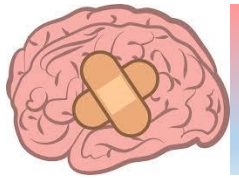

Cerebral blood flow
Plateau
Mean arterial blood pressure
A
Blood vessel
Transmural pressure
B
$\uparrow CO_2$
$PaCO_2$~Vasodilation
C
Endothelin-1
Thromboxane
Nitric oxide
Endothelium
Smooth muscle
D
Neuron
Acetylcholine
Nitric oxide
Serotonin
Neuropeptide Y



PHYSIOLOGY



CPP = MAP – ICP



PATHOPHYSIOLOGY

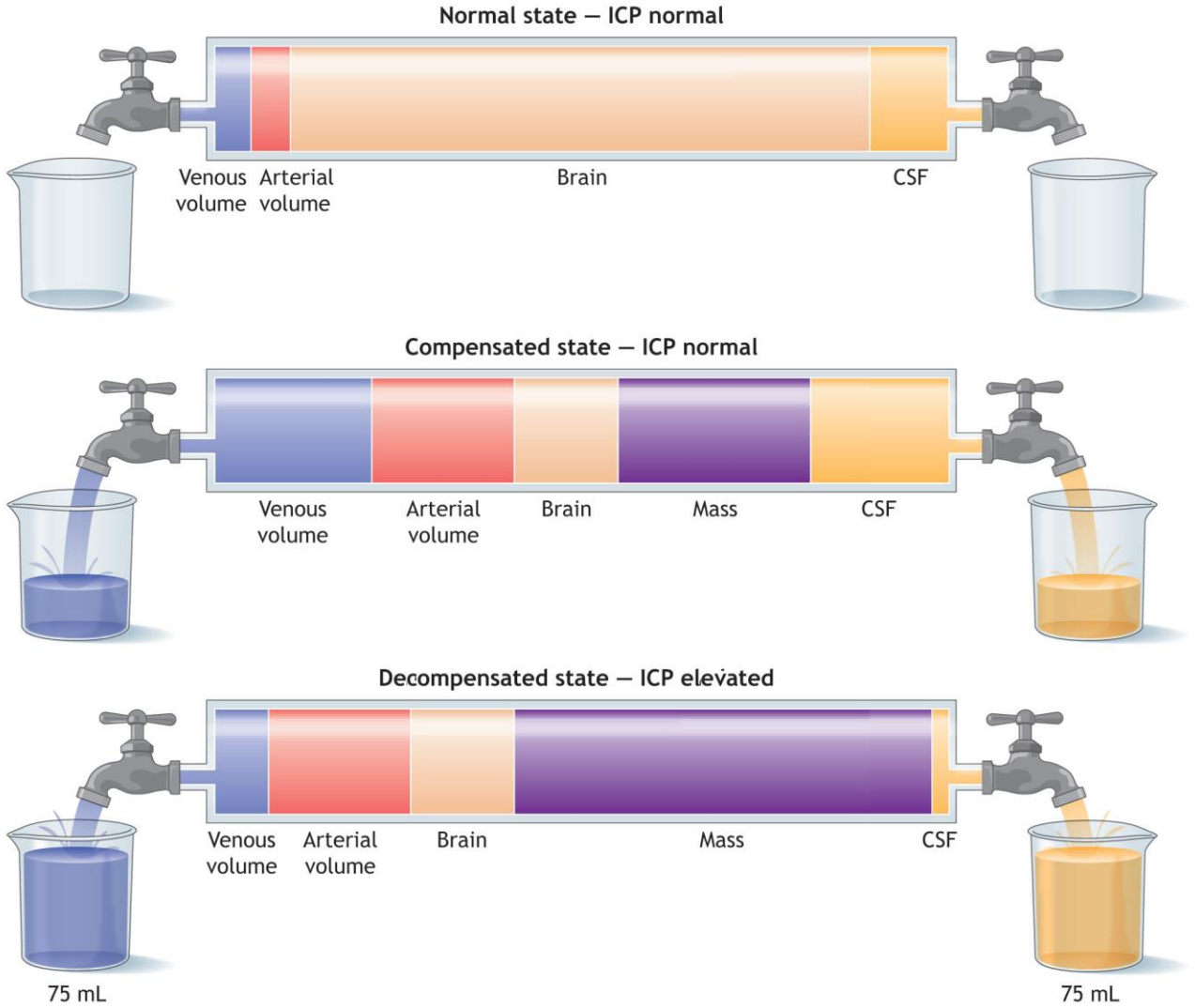
	MAP	– ICP	= CPP
Normal	90	10	80
Cushing's Response	100	20	80
Hypotension	50	20	30

10 mm Hg	=	Normal
>20 mm Hg	=	Abnormal
>40 mm Hg	=	Severe

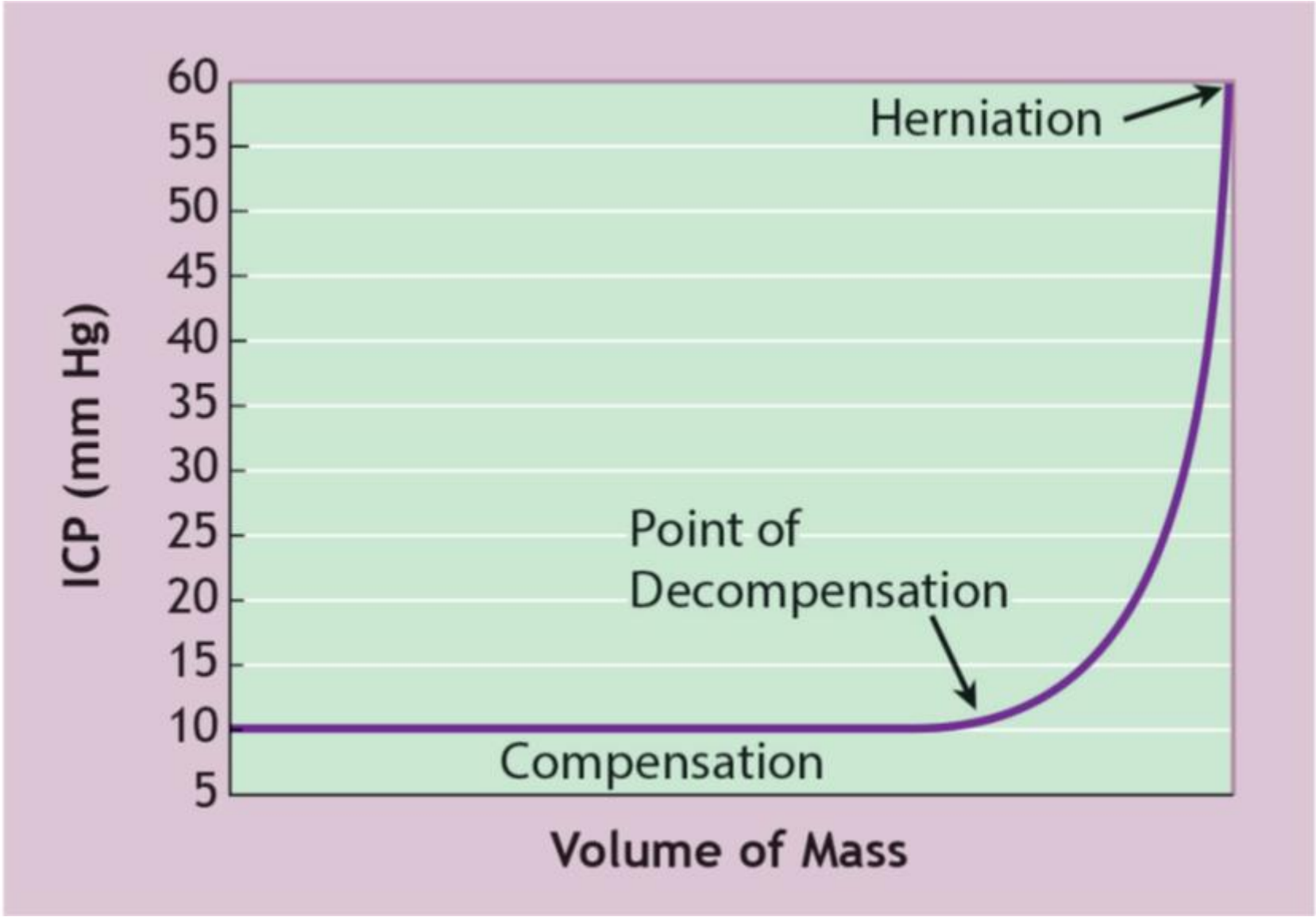
TABLE 257-2 Intracranial Pressure by Age Group

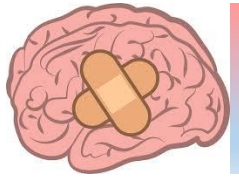
Age Group	Intracranial Pressure (mm Hg)
Adults	<10–15
Young children	3–7
Infants	1.5–6.0

MONROE-KELLIE DOCTRINE



Volume-Pressure curve



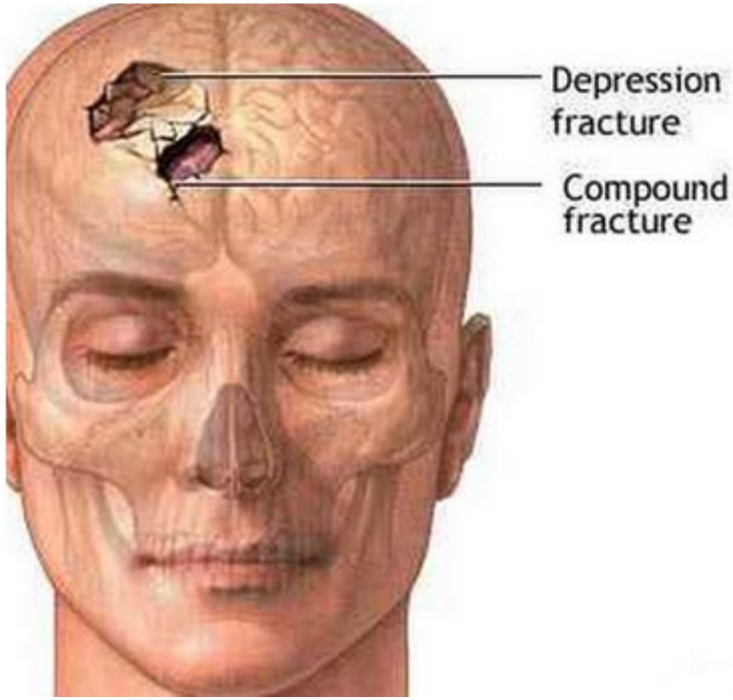


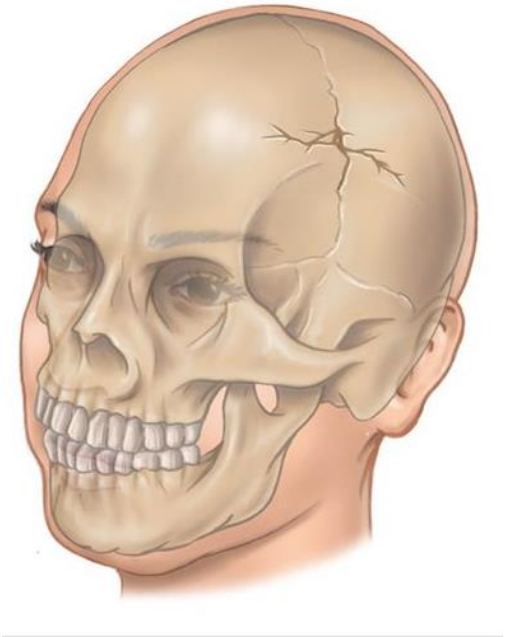
CLASSIFICATIONS OF HEAD INJURY

GLASGOW COMA SCALE *(glasgowcomascale.org)*		
ORIGINAL SCALE	REVISED SCALE	SCORE
EYE OPENING (E)	**EYE OPENING (E)**	
Spontaneous	Spontaneous	4
To speech	To speech	3
To pain	To pain	2
None	None	1
	Non-testable	NT
VERBAL RESPONSE (V)	**VERBAL RESPONSE (V)**	
Oriented	Oriented	5
Confused	Confused	4
Inappropriate words	Inappropriate words	3
Incomprehensible sounds	Incomprehensible sounds	2
None	None	1
	Non-testable	NT
BEST MOTOR RESPONSE (M)	**BEST MOTOR RESPONSE (M)**	
Obeys commands	Obeys commands	6
Localizes pain	Localizes pain	5
Flexion withdrawal to pain	Flexion withdrawal to pain	4
Abnormal flexion (decorticate)	Abnormal flexion (decorticate)	3
Extension (decerebrate)	Extension (decerebrate)	2
None (flaccid)	None (flaccid)	1
	Non-testable	NT

Skull fracture

- Location: vault vs basilar
- Pattern: linear, depressed, comminuted
- Open vs closed





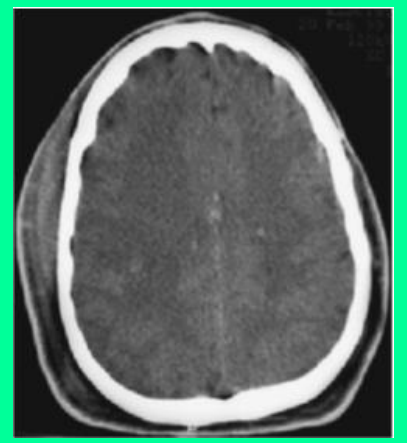
Intracranial lesions

Focal

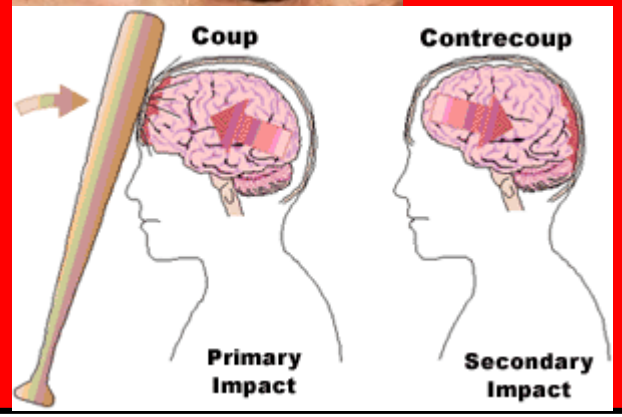
- Epidural
- Subdural
- Intracerebral

Diffuse

- Concussion
- Multiple contusions
- Hypoxic/ischemic injury
- Axonal injury



Blunt trauma



Penetrating trauma

Pathophysiology

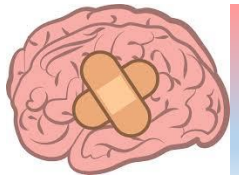
Primary

- initial insult due to mechanical forces that produce high levels of direct damage and strain to the brain parenchyma
  - Contusions
  - Hematoma (subdural, epidural, intraparenchymal, intraventricular, subarachnoid)
  - Diffuse axonal injury (stress or damage to axons)

Secondary

- Results by **secondary neurotoxic cascade** due to secondary insults (hypotension, hypoxemia, hyperglycemia) resulting in
  - Cerebral edema
  - Cerebral herniation

APPROACH TO TBI MANAGEMENT

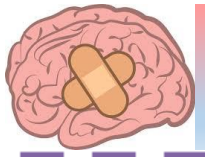


PREHOSPITAL CARE

- ABCDE
- Minimize secondary brain injury
- Administer oxygen
- C-spine protection
- Maintain normal blood pressure

- Initial clinical findings and physical exam as reported by EMS are an essential component of triaging and managing TBI

TRIAGE



STEP 1

Measure vital signs and level of consciousness

- Airway obstruction
- GCS <13
- RR <10 or >30 breaths/minute
- SBP <90 mmHg
- HR <60 beats/minute or >110 beats/minute
- SpO_2 <90% on room air

NO

STEP 2

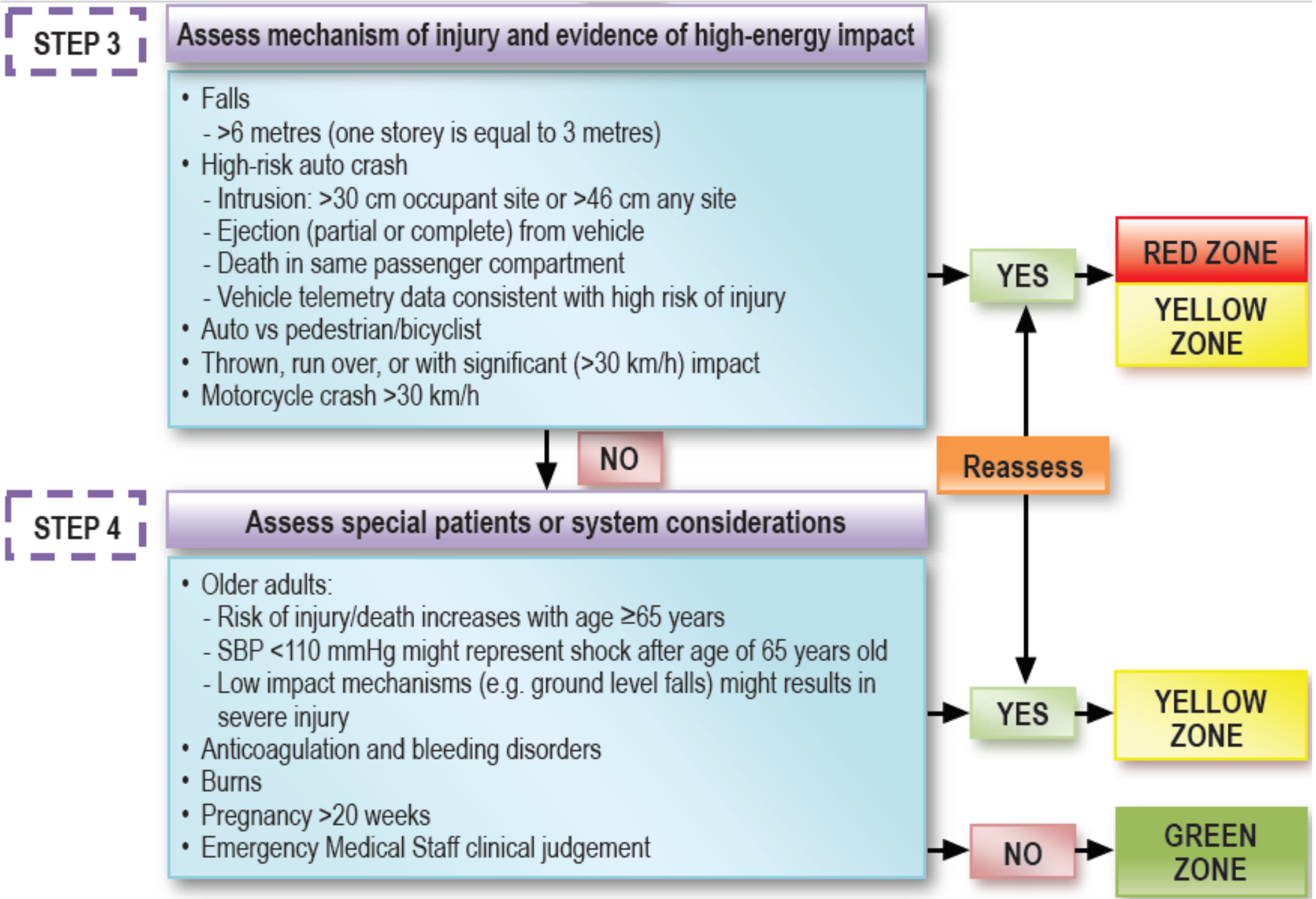
Assess anatomy of injury

- All penetrating injuries to head, neck, torso and extremities proximal to elbow and knee
- Chest wall instability/deformity (flail chest)
- Two or more proximal long-bone fractures
- Crushed, degloved or mangled or pulseless extremity
- Amputation proximal to wrist and ankle
- Pelvic fractures
- Open or depressed skull fracture
- Paralysis

NO

YES

RED ZONE
Steps 1 and 2 attempts to identify the most injured patients


STEP 3
Assess mechanism of injury and evidence of high-energy impact
• Falls
- >6 metres (one storey is equal to 3 metres)
• High-risk auto crash
- Intrusion: >30 cm occupant site or >46 cm any site
- Ejection (partial or complete) from vehicle
- Death in same passenger compartment
- Vehicle telemetry data consistent with high risk of injury
• Auto vs pedestrian/bicyclist
• Thrown, run over, or with significant (>30 km/h) impact
• Motorcycle crash >30 km/h
YES
RED ZONE
YELLOW ZONE
NO
Reassess
STEP 4
Assess special patients or system considerations
• Older adults:
- Risk of injury/death increases with age ≥65 years
- SBP <110 mmHg might represent shock after age of 65 years old
- Low impact mechanisms (e.g. ground level falls) might results in severe injury
• Anticoagulation and bleeding disorders
• Burns
• Pregnancy >20 weeks
• Emergency Medical Staff clinical judgement
YES
YELLOW ZONE
NO
GREEN ZONE

A AIRWAY

B BREATHING

- Airway Protection
  - Endotracheal intubation if severe TBI
- Prevent hypoxaemia
- Maintain a PCO_2 of approximately 35 mm Hg.
  - Prolonged hyperventilation with $PCO_2 < 25$ mm Hg is not recommended
- Maintain cervical in-line immobilization all the time

C
CIRCULATION

- Treat primary source of hypotension
- Prevent hypotension:
  - Maintain systolic blood pressure (SBP)
    - ≥ 100 mmHg for patients 50 to 69 years OR
    - ≥ 110 mm Hg for patients 15 to 49 years OR > 70 years

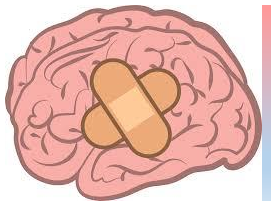
    (ATLS 10th Edition)
- Ringer's lactate solution or normal saline is recommended
- Hyponatremia is associated with brain edema and should be prevented.

D
DISABILITY

- GCS, pupillary response and neurological deficit
- If emergency intubation is necessary, obtain pre-intubation GCS

UNRESPONSIVE PATIENT WITH	MAY SUGGEST
Single fixed and dilated pupils	Intracranial hematoma with uncal herniation
Bilateral fixed and dilated pupils	Increased ICP with poor brain perfusion Bilateral uncal herniation Drug effect (eg: Atropine) Severe hypoxia
Bilateral pinpoints pupils	Central pontine lesion Opiate exposure

Don’t forget to complete your secondary survey



DIAGNOSTIC IMAGING

Canadian CT Head Rule

CT head is only required for minor head injury patients with any one of these findings:

High Risk (for Neurological Intervention)

1. GCS score < 15 at 2 hrs after injury
2. Suspected open or depressed skull fracture
3. Any sign of basal skull fracture*
4. Vomiting ≥ 2 episodes
5. Age ≥ 65 years

Medium Risk (for Brain Injury on CT)

6. Amnesia before impact ≥ 30 min
7. Dangerous mechanism ** *(pedestrian, occupant ejected, fall from elevation)*

*Signs of Basal Skull Fracture
- hemotympanum, 'racoon' eyes, CSF otorrhea/ rhinorrhea, Battle's sign

** Dangerous Mechanism
- pedestrian struck by vehicle
- occupant ejected from motor vehicle
- fall from elevation ≥ 3 feet or 5 stairs

Rule Not Applicable If:
- Non-trauma cases
- GCS < 13
- Age < 16 years
- Coumadin or bleeding disorder
- Obvious open skull fracture

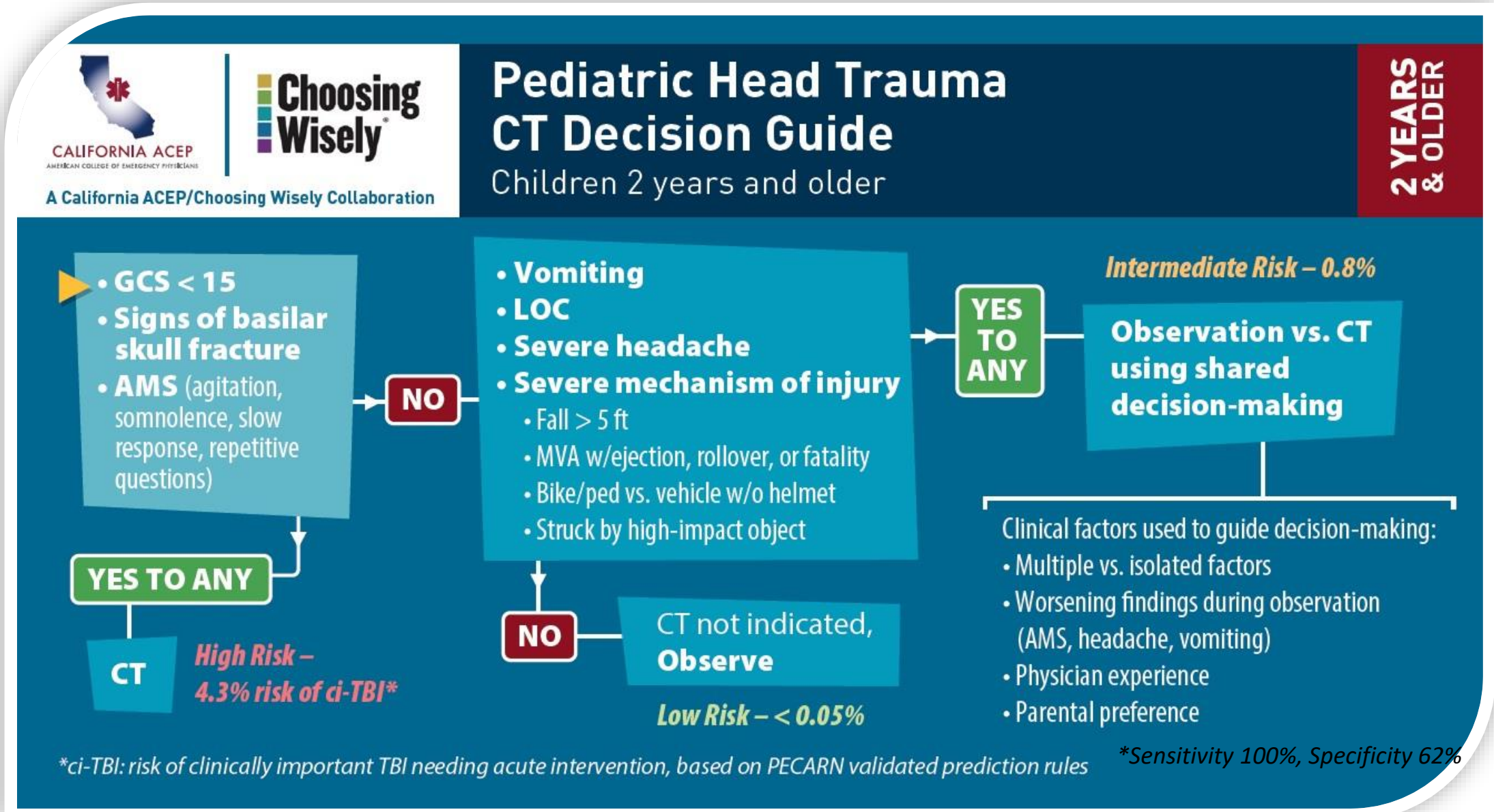
*Sensitivity 100%, Specificity 50.6%

New Orleans Criteria

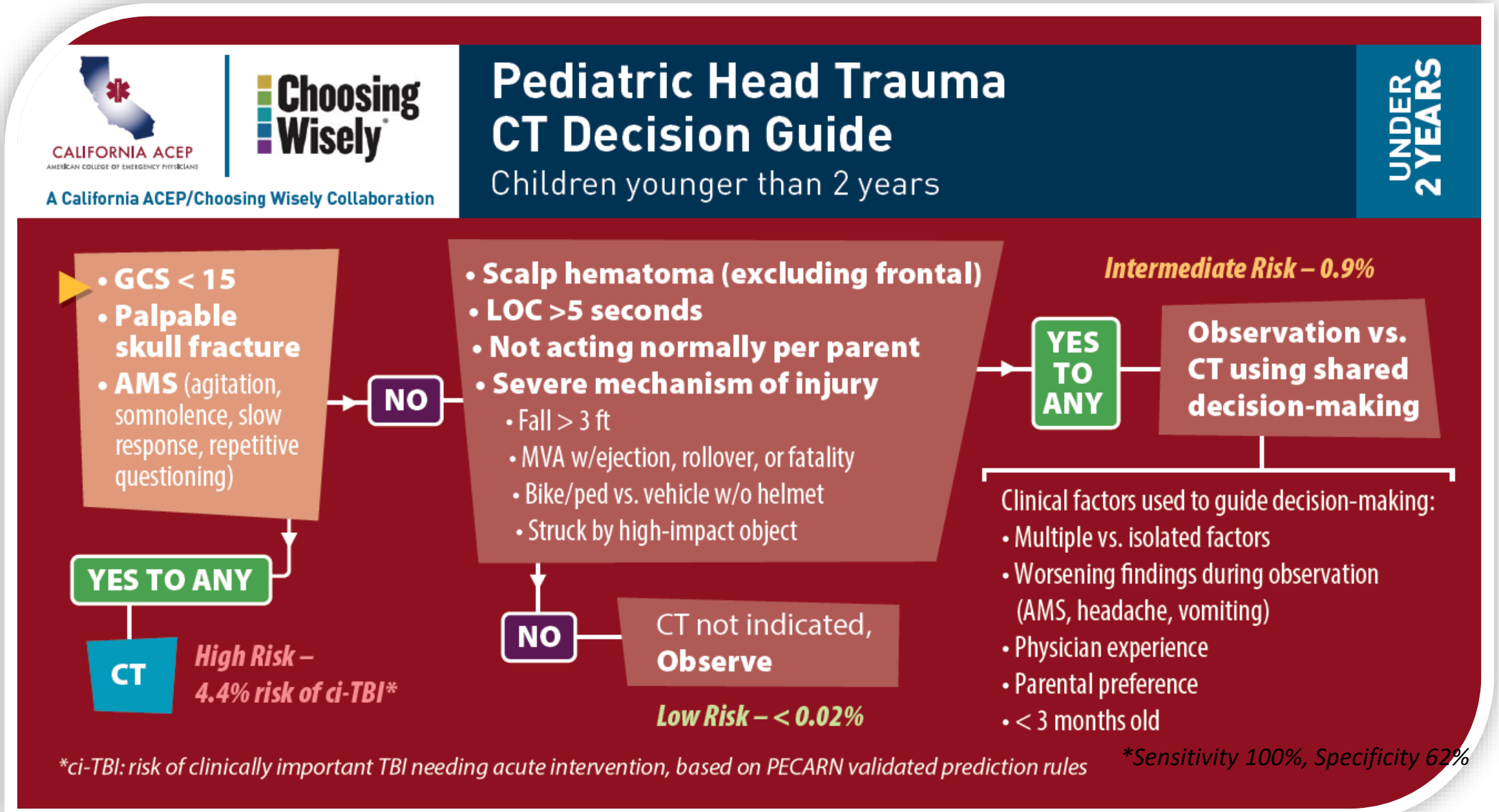
- Recommend CT after minor TBI if:
- GCS=15 and one of the following
  - Headache
  - Vomiting
  - Age >60 years
  - Drug or alcohol intoxication
  - Deficits in short term memory
  - Seizure
  - Evidence of injury above clavicle
- 100% Sensitive

*Sensitivity 100%, Specificity 12.7%

***Source:** JAMA. 2005;294(12):1511-1518. doi:10.1001/jama.294.12.1511 on Comparison of the Canadian CT Head Rule and the New Orleans Criteria in Patients With Minor Head Injury*

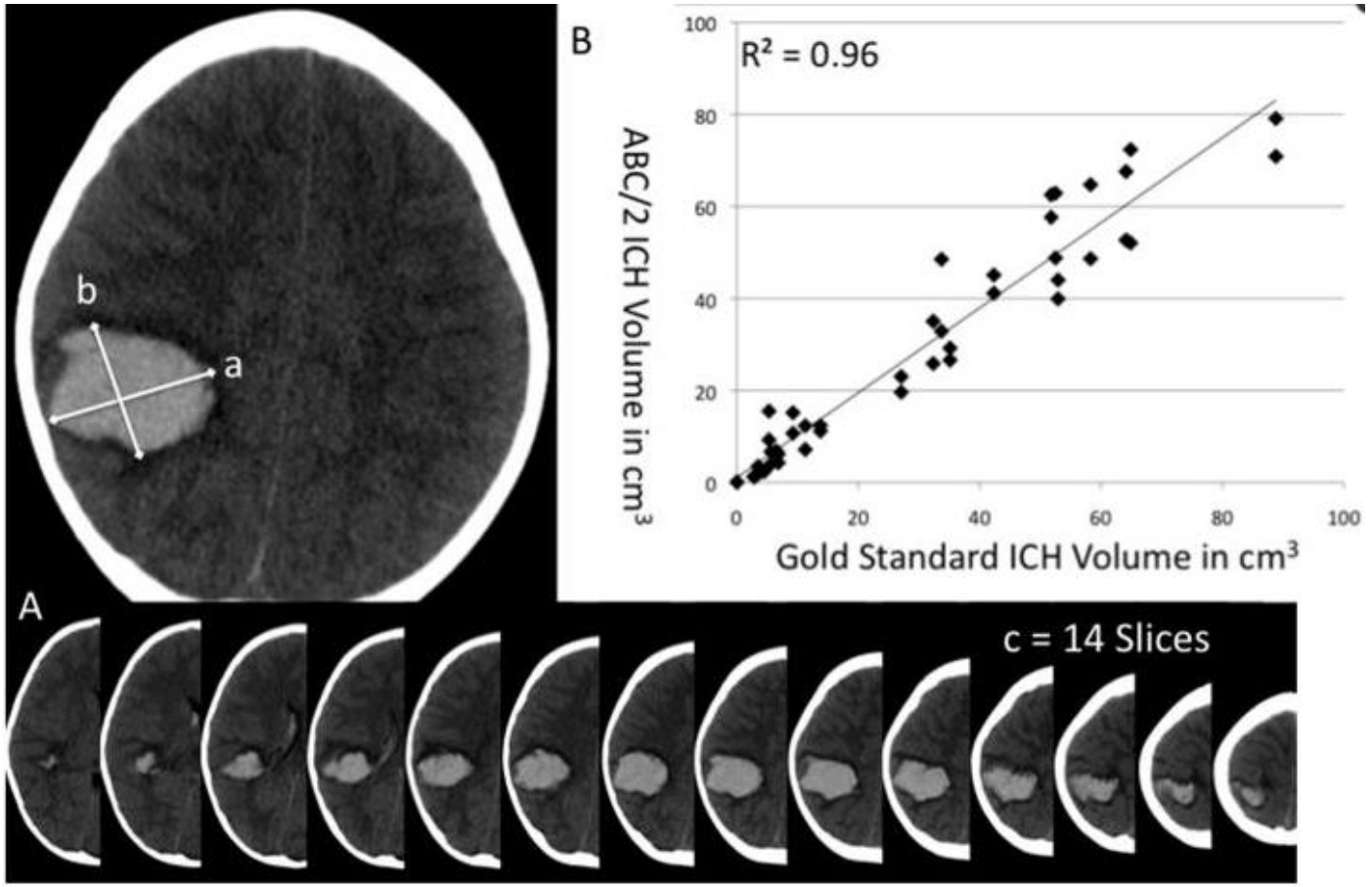


***Source**: Ann Emerg Med. 2014 Aug; 64(2): 145–152.e5 on Comparison of PECARN, CATCH, and CHALICE Rules for Children with Minor Head Injury: A prospective cohort study*



***Source**: Ann Emerg Med. 2014 Aug; 64(2): 145–152.e5 on Comparison of PECARN, CATCH, and CHALICE Rules for Children with Minor Head Injury: A prospective cohort study*

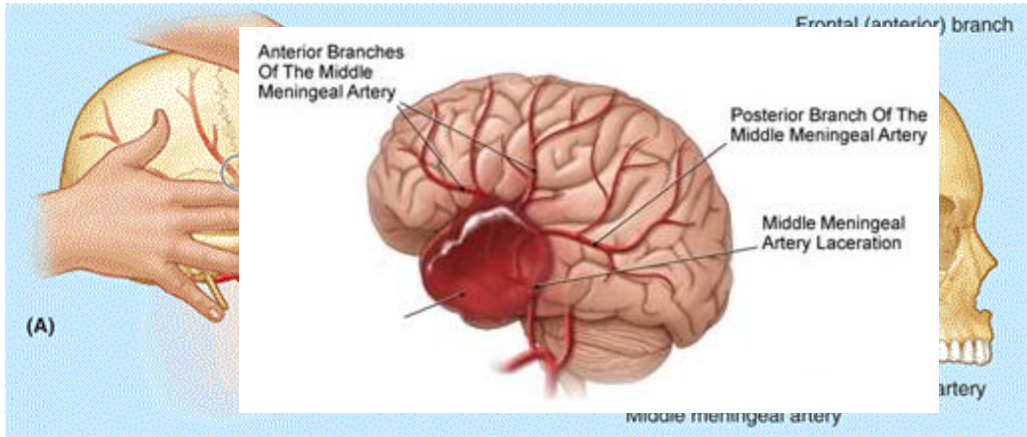
How to calculate bleed size?



ABC/2: A baseline intracerebral haemorrhage volume of >50-60 mL is a poor prognostic marker!

EPIDURAL HEMATOMA

- Blood in between skull and dura mater
- Classic: middle meningeal artery tear
- Lenticular / biconvex
- Lucid interval
- Can be rapidly fatal
- Early evacuation essential



SUBDURAL HEMATOMA

- Sudden acceleration-decelaration → tearing of bridging dural veins/ brain laceration
- Venous origin hence collect more slowly
- Susceptible for elderly/ chronic alcoholics/ children < 2years
- *Rapid surgical evacuation recommended, especially if thickness >10mm or > 5 mm shift of midline

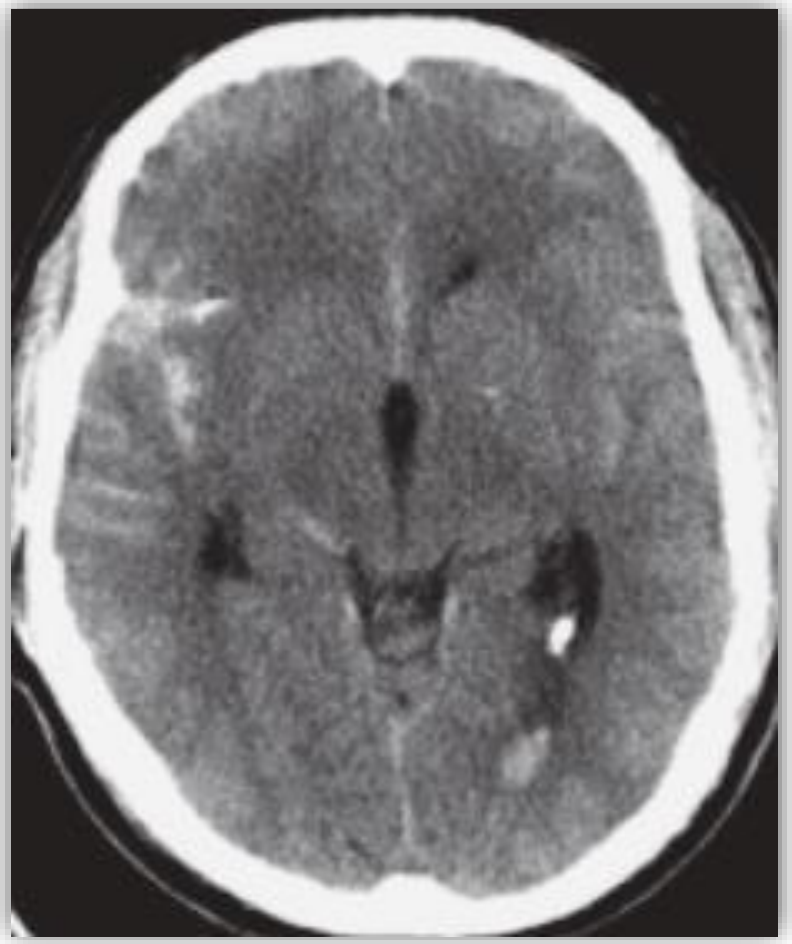
**Source: UptoDate Neurosurgery.2006;58(3Suppl): S16 on Surgicalmanagement of acute subdural hematomas*

CEREBRAL CONTUSION/ INTRACEREBRAL HEMATOMA

- Most common: frontal / temporal lobes
- Coup / contracoup injuries
- Most conscious patients: no operation

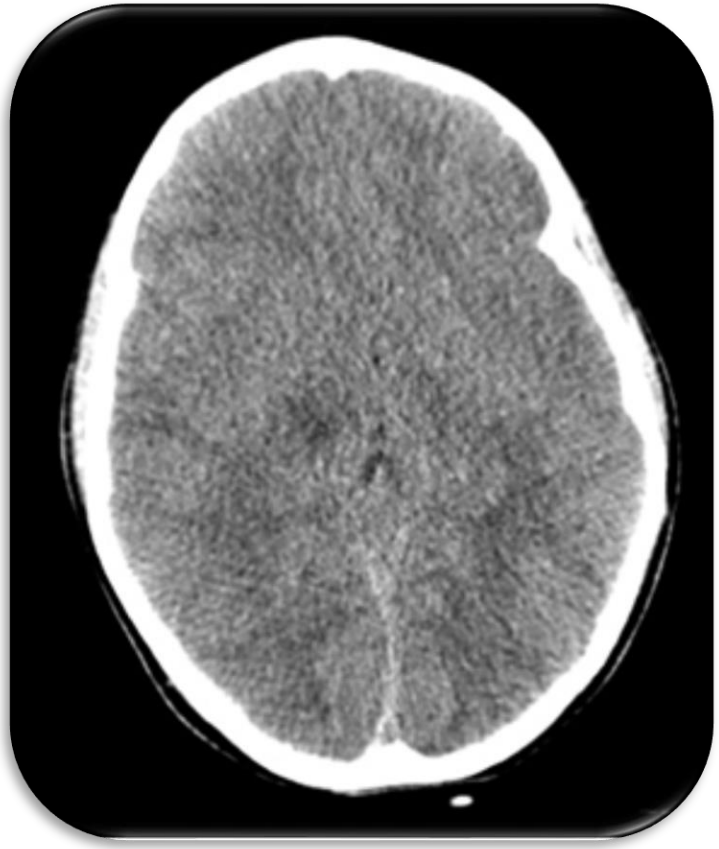
SUBARACHNOID HEMORRHAGE

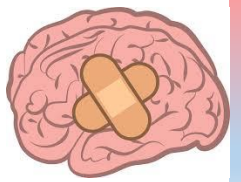
- Disruption of parenchyma and subarachnoid vessels → blood in CSF
- Headache, photophobia, meningeal signs
- Traumatic SAH vs non traumatic has 3x higher mortality risk (42% vs 14%)



DIFFUSE AXONAL INJURY

- Disruption of axonal fibers in white matter and brainstem
- Range from mild concussion to severe ischemic insult
- Severe DAI, edema can develop rapidly → irreversible neurologic deficits
- CT findings: Normal but classic punctuate hemorrhagic injury along grey-white junction of cerebral cortex and within deep structure of brain

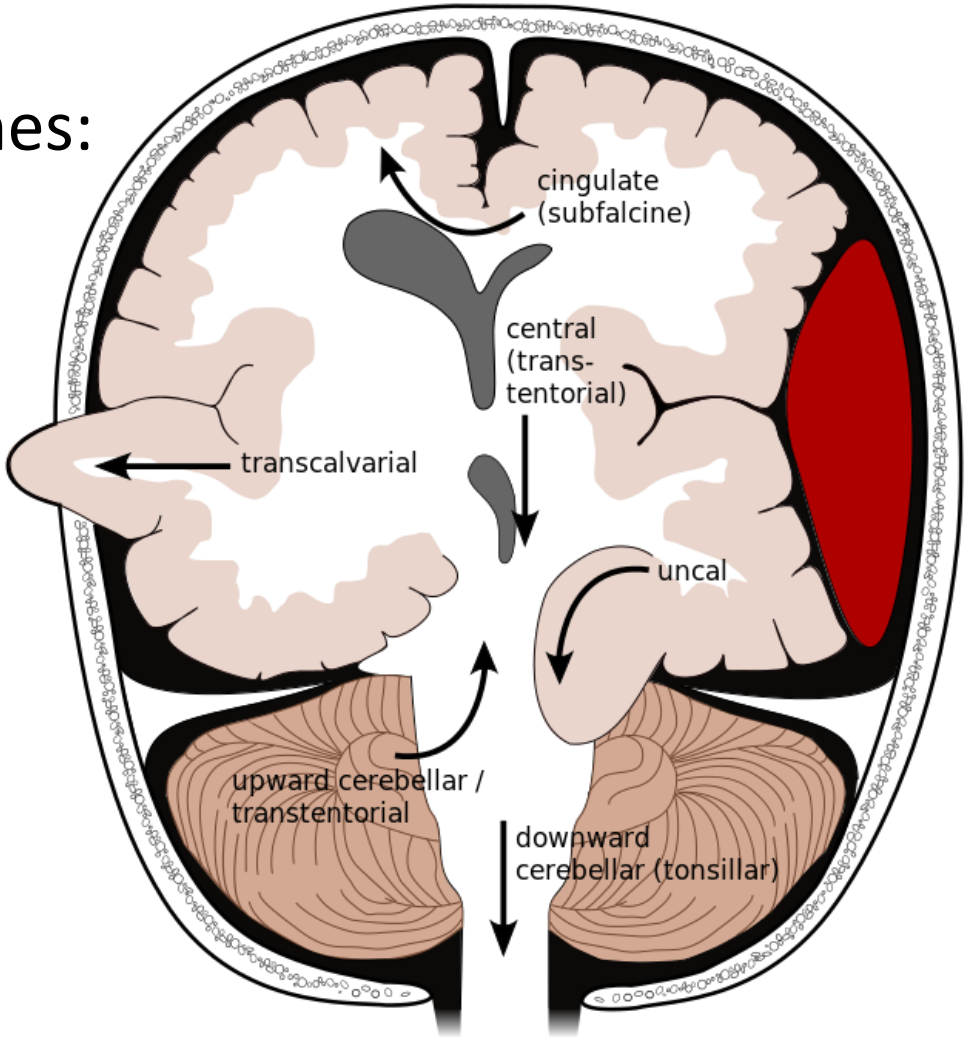




ACUTE COMPLICATIONS

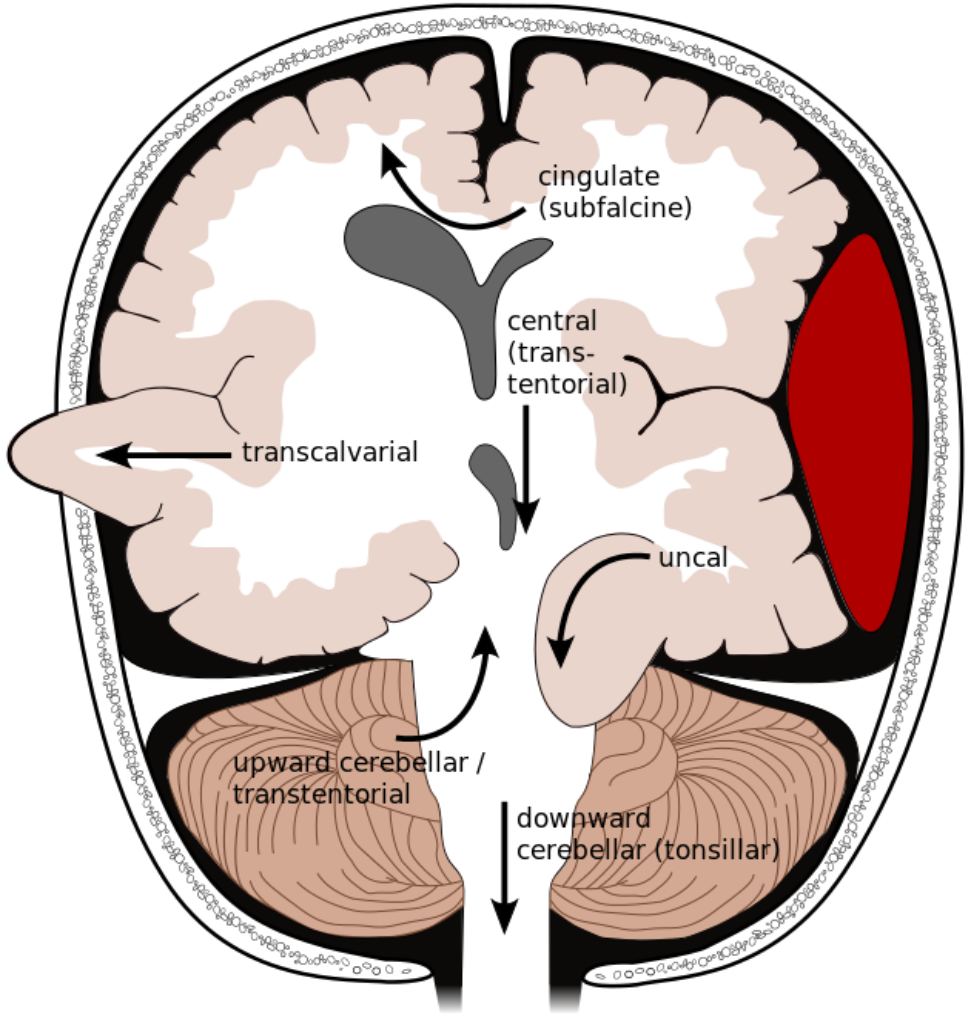
BRAIN HERNIATION

- There are 5 major brain herniation syndromes:
  - Uncal transtentorial
  - Central transtentorial
  - Cerebellotonsillar
  - Upward posterior fossa
  - Subfalcine



UNCAL TRANSTENTORIAL

- Uncus of the temporal lobe is displaced inferiorly through the medial edge of the tentorium.
- Due to an expanding lesion in the temporal lobe or lateral middle fossa.
- Cx:Ipsilateral fixed & dilated pupil due to compression of parasympathetic fibers running with the 3rd cranial (oculomotor) nerve.
- Compresses the pyramidal tract,results in contralateral motor paralysis.

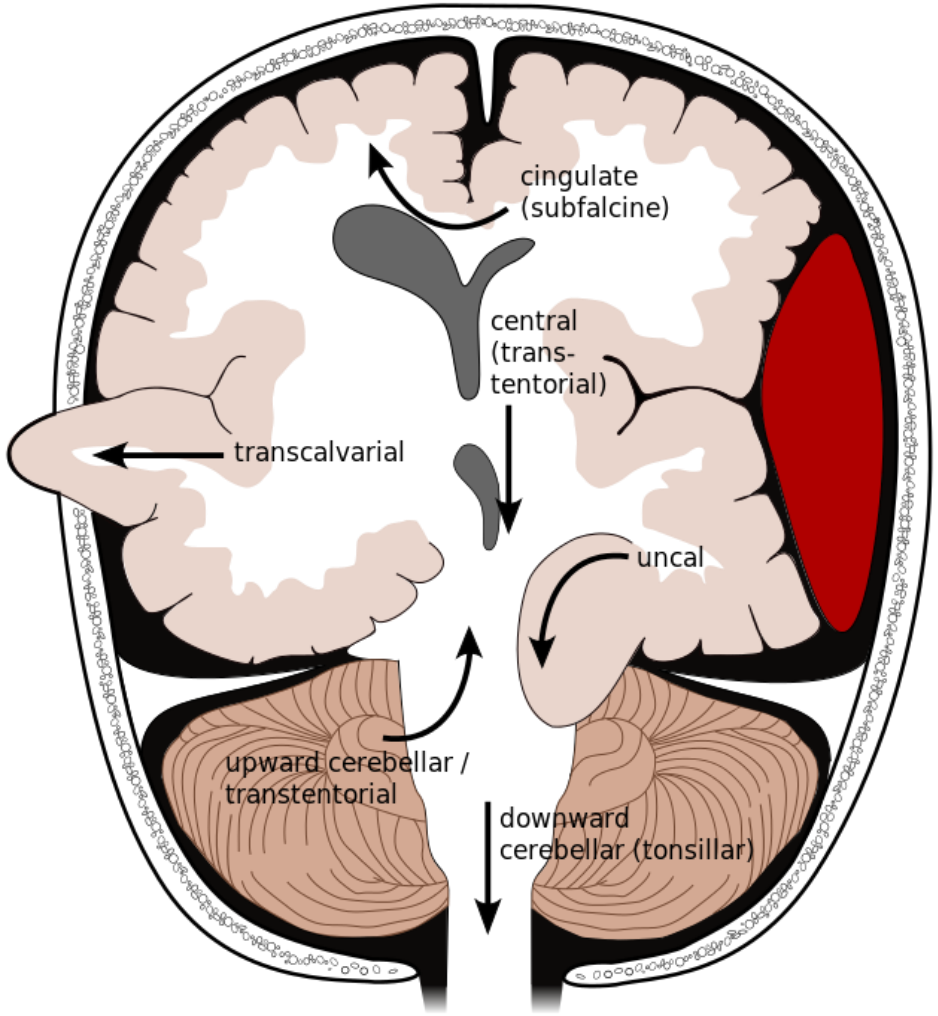


SUBFALCINE

- Unilateral SOL pushes across the midline under the inferior “free” margin of falx,extending to contralateral side
- Ipsilateral ventricle appears compressed and displaced across midline
- Complications:

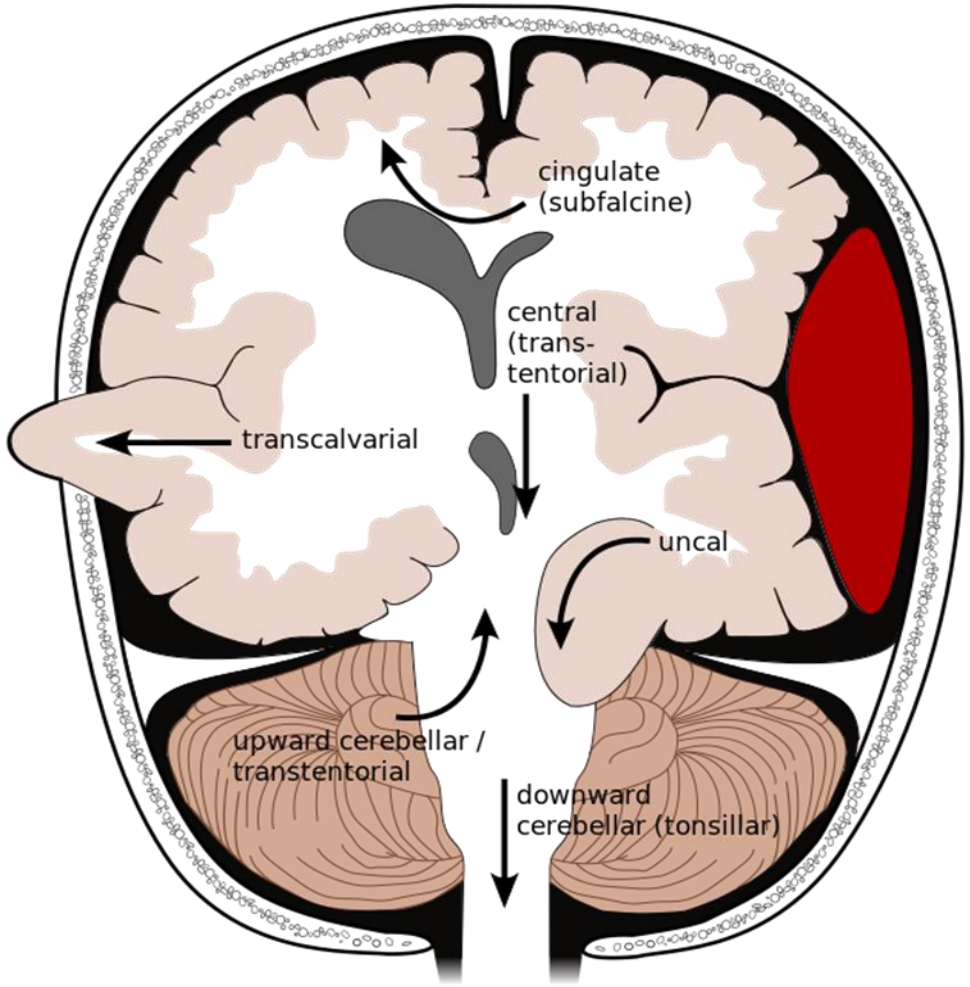
  Obstructive hydrocephalus

  Secondary ACA infarct



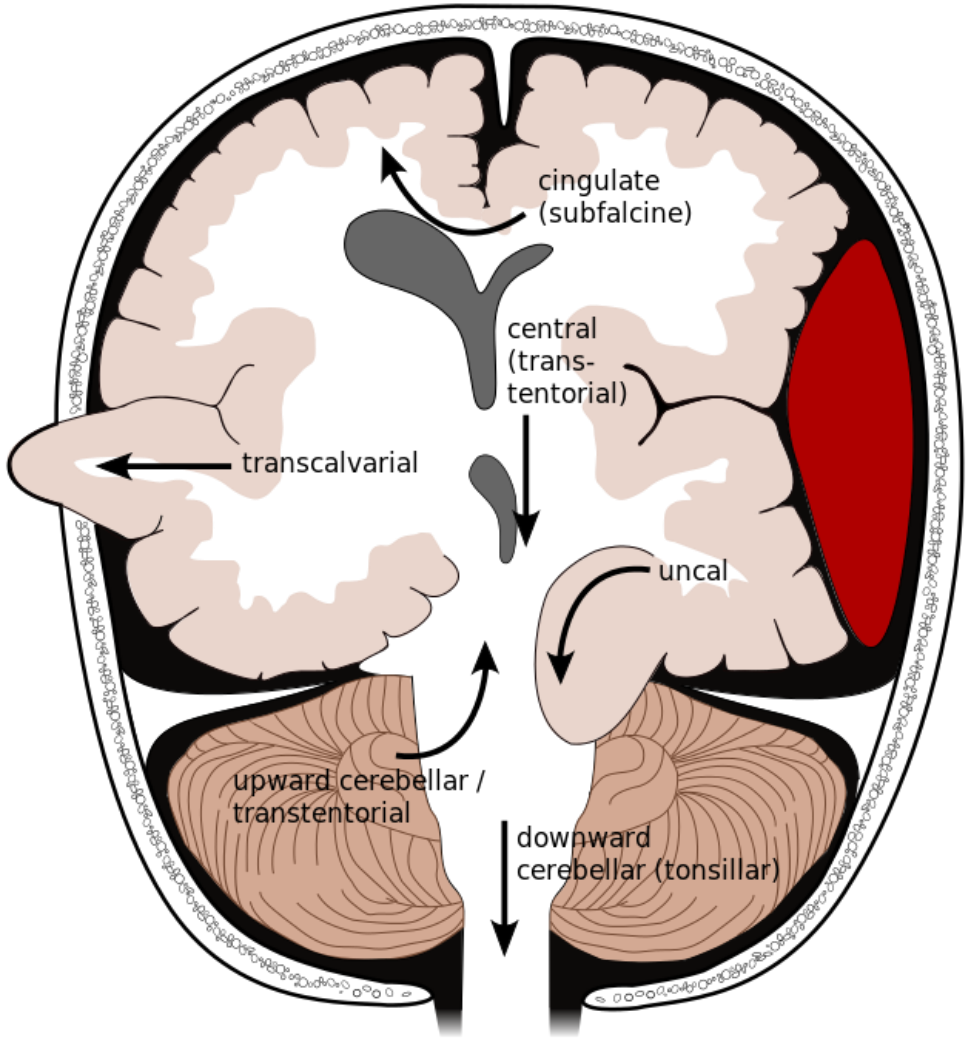
CENTRAL TRANSTENTORIAL

- Midline lesion or diffuse swelling of cerebral hemisphere results in vertical displacement of the midbrain and diencephalon through tentorial hiatus.
- Most prominent symptoms are bilateral pinpoint pupils, bilateral Babinski's signs, and increased muscle tone.
- Fixed pinpoint pupils follow along with prolonged hyperventilation and decorticate posturing.



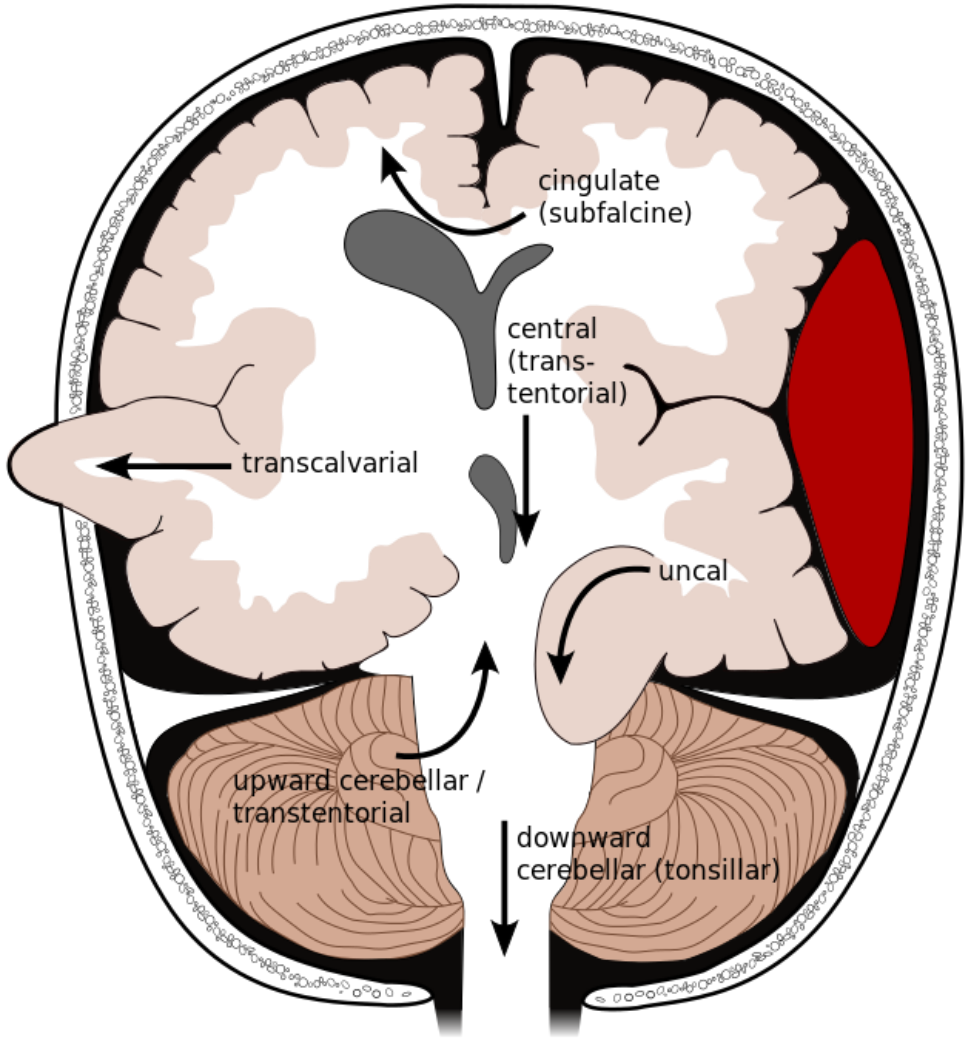
CEREBELLAR TONSILAR

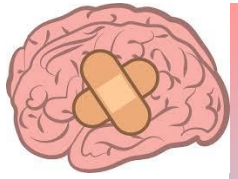
- Cerebellar tonsils are displaced inferiorly and become impacted into foramen magnum
- pinpoint pupils, flaccid paralysis, and sudden death.



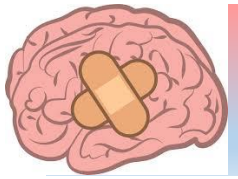
UPWARD CEREBELLAR TRANSTENTORIAL

- Caused by expanding posterior fossa mass
- Cerebellum move up through the tentorial opening
- Conjugate downward gaze with absence of vertical eye movements and pinpoint pupils.





SEVERE TRAUMATIC BRAIN INJURY



CEREBRAL RESUSCITATION

Principles

Restoring cerebral blood flow and preventing secondary insult

- Physical
- Physiological
- Pharmacological
- Surgical

Consult neurosurgeon early!

PHYSICAL

- Head elevation 30°
- Avoid excessive flexion of the head or pressure around the neck that may impair cerebral venous drainage
- Insertion of orogastric tube (in basal skull #)
- Insertion of urinary catheter (if no bladder injury)

PHYSIOLOGICAL

- Ensure normovolemia, maintain SBP>100mgHg to ensure adequate CPP
- Ensure normothermia (aim 36-37°C)
- Adequate oxygenation
- Ensure normocapnia, aim 35-45mmHg
- Maintain glycemic control 4-8mmol/l

PHARMACOLOGICAL

- Control epileptic activity with anti epileptic
- Consider RSI with cerebroprotective advantages.
- Ensure adequate sedation and analgesic

Pharmacotherapy for Drug-Assisted Intubation

- Propofol is recommended for the control of ICP
- Short acting IV benzodiazapines, such as midazolam, may be used for sedation and reversed with flumazenil

(ATLS 10th Edition, BrainTraumaFoundation.org 4th Edition)

- Post-intubation sedation and analgesia

DRUG	DOSAGE
SEDATION	
Benzodiazepine Midazolam	IV Infusion 0.05 – 0.1mg over at least 2 – 5 mins
ANALGESIA	
Opiods Fentanyl Morphine	 0.5 - 2µg/kh/h continuous infusion 0.05 – 0.1mg/kg/hr continuous infusion

(CPG Early Mangement of Head Injury in Adults 3rd Edition 2015)

DRUGS	ADVANTAGES	DISADVANTAGES
FENTANYL	• Attenuate rises in BP & HR • Neuroprotective in patient with raised ICP.	
LIDOCAINE	• Bronchodilator effect	• Caused hypotensive
ETOMIDATE	• Reduced ICP • Rarely reduced BP	• No analgesic property • Can decreased seizure threshold,myoclonic jerks
KETAMINE	• Increased BP-Neuroprotective (suited in TBI with normal/reduced BP) • Bronchodilator • Dissociative amnesia	Increased ICP Increased secretions
PROPOFOL	• Stop seizure • Bronchodilation	• No analgesic • Cause hypotensive ⇨ reduced CBF
MIDAZOLAM	• Anticonvulsant • Reversible	• Lack of analgesic • Apnea
SUCCINYLCHOLINE	• Short acting	
ROCURONIUM	• Ideal in patient status epilepticus (due to long action of paralysis)	

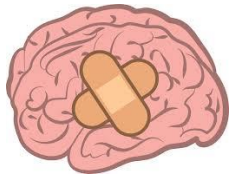
SURGICAL

- Decompression craniectomy
- Surgical drainage of hematoma

Other clinical parameters

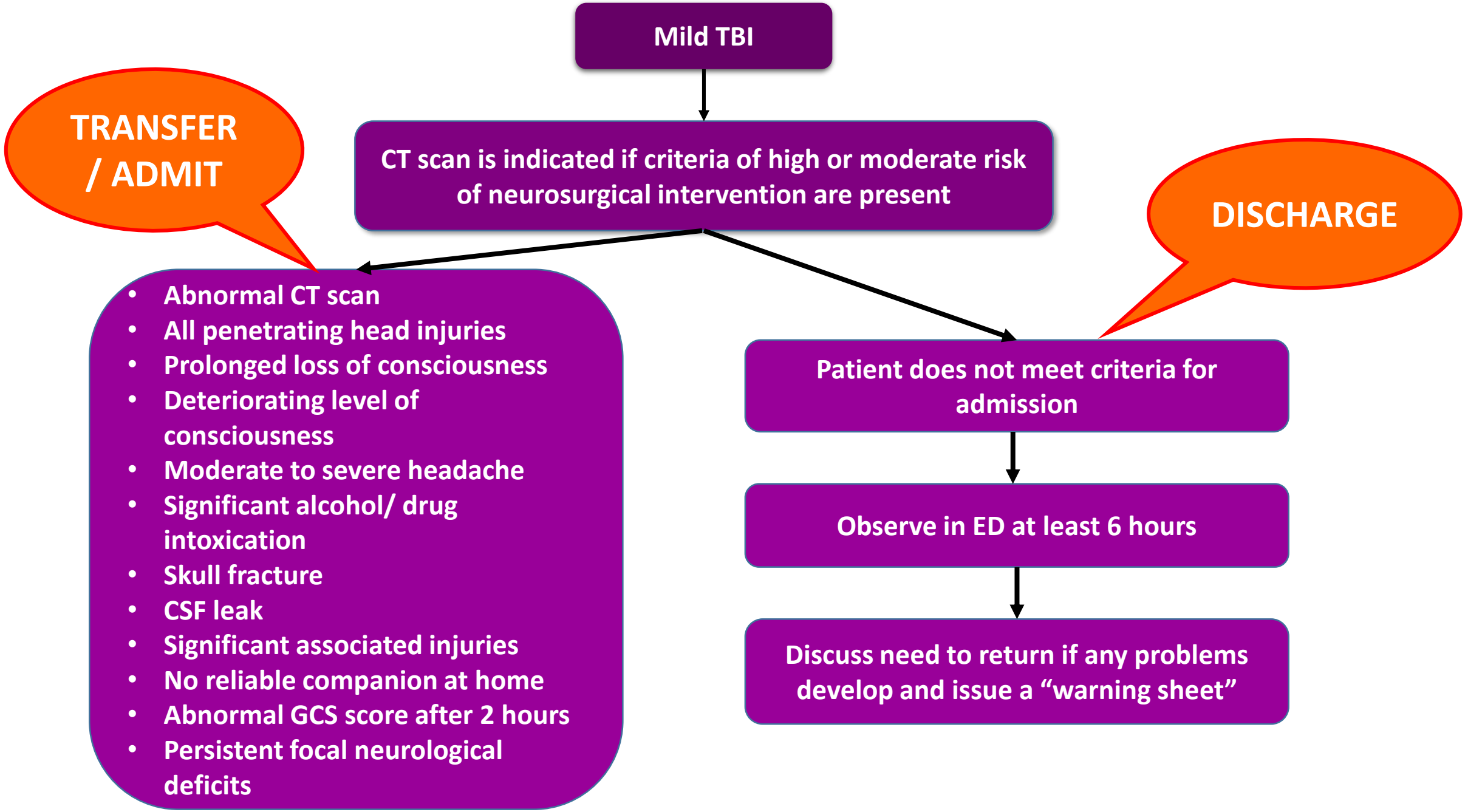
PARAMETERS	RANGE	PARAMETERS	RANGE
Temperature	**36–38°C**	PaO2	**≥ 100 mm Hg**
Glucose	**80–180 mg/dL**	PaCO2	**35–45 mm Hg**
Hemoglobin	**≥ 7 g/dl**	pH	**7.35–7.45**
Platelets	**≥ 75 X 103/mm3**	CPP	**≥ 60 mm Hg***
INR	**≤ 1.4**	Intracranial pressure	**5–15 mm Hg***
Na	**135–145 meq/dL**	PbtO2	**≥ 15 mm Hg***
Pulse oximetry	**≥ 95%**		

Data from ACS TQIP Best Practices in the Management of Traumatic Brain Injury. ACS Committee on Trauma, January 2015.



MILD TRAUMATIC BRAIN INJURY

- Post resuscitation GCS 13 – 15
- Often sustained a concussion; transient loss of neurologic function following a head injury
- Can be confounded by alcohol or other intoxicants
- Physical findings in isolated mild TBI are often normal
- Indications for CT Brain are based on Canadian CT Head Rules/ New Orleans


Mild TBI
CT scan is indicated if criteria of high or moderate risk of neurosurgical intervention are present
TRANSFER / ADMIT
Abnormal CT scan
All penetrating head injuries
Prolonged loss of consciousness
Deteriorating level of consciousness
Moderate to severe headache
Significant alcohol/ drug intoxication
Skull fracture
CSF leak
Significant associated injuries
No reliable companion at home
Abnormal GCS score after 2 hours
Persistent focal neurological deficits
DISCHARGE
Patient does not meet criteria for admission
Observe in ED at least 6 hours
Discuss need to return if any problems develop and issue a “warning sheet”

Sekiranya terdapat sebarang kemusykilan atau ketika kecemasan, sila hubungi kami di talian 088 522 699 atau 522 [illegible]

Tandatangan Pegawai Perubatan

JABATAN KECEMASAN DAN TRAUMA
Hospital Wanita dan Kanak-Kanak Sabah
Beg berkunci 183, 88995 Kota Kinabalu, Sabah

JABATAN KECEMASAN DAN TRAUMA
HOSPITAL WANITA DAN KANAK-KANAK SABAH

ARAHAN AMARAN DISCAJ BAGI PESAKIT YANG MENGALAMI KECEDERAAN OTAK YANG RINGAN

(MILD TRAUMATIC BRAIN INJURY;WARNING DISCHARGE INSTRUCTION)

Nama Pesakit:

No Kad Pengenalan:

Tarikh:

Kami telah memeriksa dan mendapati tiada tanda-tanda yang menunjukkan kecederaan kepala anda adalah serius. Walaubagaimanapun, gejala-gejala baru dan tidak di jangka boleh timbul setelah beberapa jam hingga beberapa hari selepas kecederaan. Tempoh 24 jam yang pertama adalah sangat penting dan anda harus sentiasa bersama seseorang yang boleh terus memerhatikan anda dalam tempoh tersebut.Jika terdapat tanda-tanda tersebut, sila hubungi doktor atau ke hospital berdekatan dengan segera.

ARAHAN AMARAN DISCAJ

Arahan aran discaj bagi pesakit yang mengalami kecederaan otak yang ringan (Mild Traumatic Brain Injury; Warning Discharge Instruction)

TANDA-TANDA YANG PERLU DI AMBIL BERAT:-

1. Mengantuk atau sukar dikejutkan daripada tidur
2. Loya dan Muntah
3. Sawan
4. Pendarahan atau keluar cecair dari rongga hidung atau telinga
5. Sakit kepala yang berterusan
6. Lemah atau kebas pada tangan dan kaki
7. Keliru dan tingkahlaku yang pelik
8. Saiz anak mata yang tidak sama di kedua belah mata, pergerakan mata yang tidak biasa, imej penglihatan nampak dua (double vision) dan lain-lain masalah berkaitan penglibatan.
9. Nadi yang terlalu cepat atau terlalu perlahan atau pernafasan yang tidak normal.

Sekiranya ada kebengkakan pada bahagian yang tercedera, letakkan bungkusan ais.Pastikan bahagian tersebut dilapis i dengan tuala atau kain di antara permukaan kulit dan bungkusan ais. Sekiranya bengkakan ilu semakin membesar, sila hubungi kami atau datang ke hospital yang berdekatan dengan segera.

Anda boleh makan dan minum seperti biasa. Namun elakkan minuman beralkohol sekurang kurangnya 3 hari selepas kecederaan.

Elakkan mengambil ubat tidur atau ubat penahan kesakitan yang lebih kuat daripada Acetaminophen (paracetamol) dalam tempoh 24 jam.

Elakkan mengambil ubatan yang mengandungi aspirin

CASE STUDY

DOES SKULL XRAY HAS ROLE IN SUSPECTED TBI?

NICE Guidance - Head injury: assessment and early management (last updated on 2017)

When compared with autopsy, X-ray missed 19.1% of fractures while 11.9% fractures

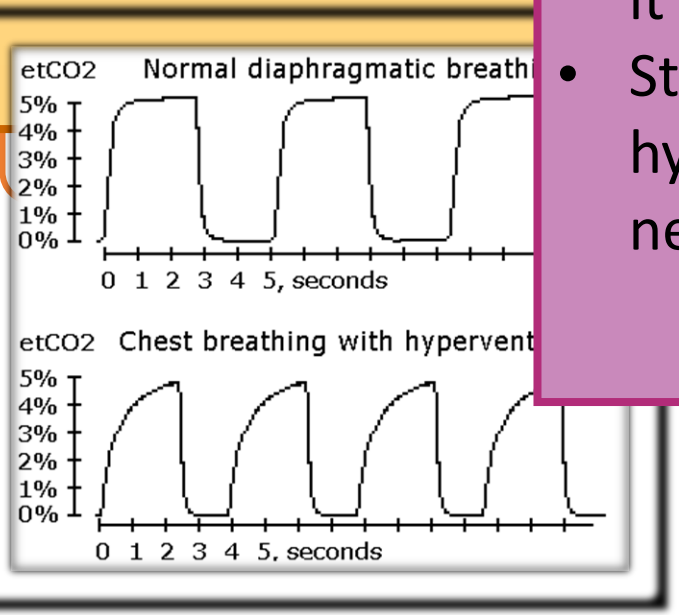
Head CT is the investigation of choice to identify ICH following head injury. The plain skull Xray **is ineffective screening tool** in predicting ICH in MHI with a mean sensitivity of 50.0% and a mean specificity of 97%. It is confirmed that **skull radiography is of little value in the clinical assessment of mild TBI**

** CPG Early Management of Head Injury in Adults 2015*

**http://jnnp.bmj.com/content/68/4/416: Value of radiological diagnosis of skull fracture in the management of mild head injury: meta-analysis*

HYPERVENTILATION

- Hyperventilation ac
  causing cerebral va
- This risk is particula
  PaCO2 is allowed <3
- Hypercarbia (PCO2
  promote vasodilatic
  intracranial pressur



HYPERTONIC SALINE

- Hypertonic saline is also used to reduce elevated ICP
- Preferable agent in hypotensive patients, as it does not cause diuresis
- Study has shown, between mannitol and hypertonic saline in hypovolemic patients, neither adequately lowers ICP

MANNITOL

CP

annitol to patients with

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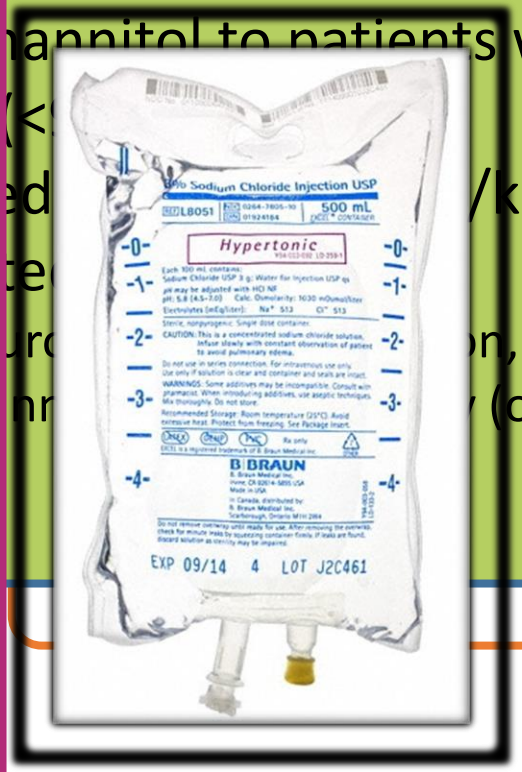
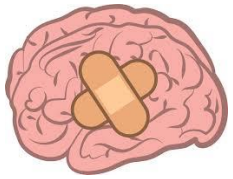




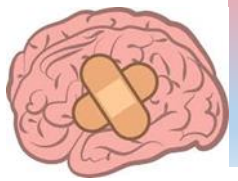
VERDICT

- Brief periods of hyperventilation
  - PaCO2 of 25 to 30 mm Hg may be necessary to manage acute neurological deterioration while other treatments are initiated (craniotomy)
- Mannitol can be used in increased ICP, provided no hypotension
- Hypertonic saline is preferred in hypotensive patient

PAEDIATRIC TRAUMA

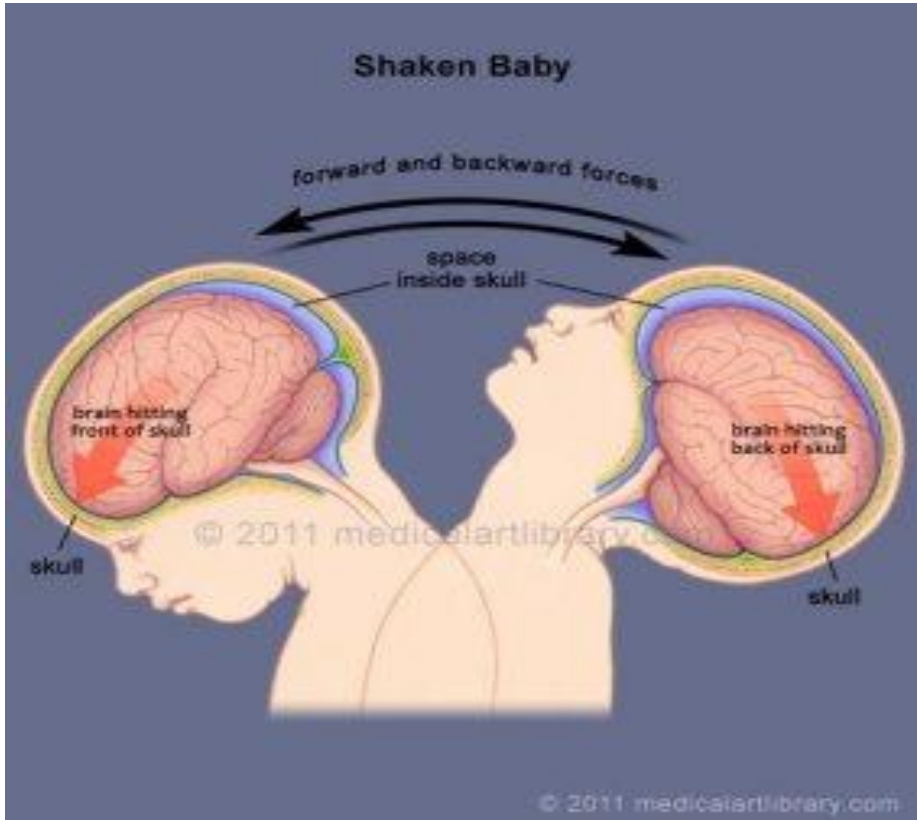
NEWBORNS	• **Delivery head injury** • **Cephalohematoma** • **Subgaleal hematoma** • **Intracranial hemorrhage**	• **Caused by head compression and traction through the birth canal (vagina delivery) with obstetric instruments** • **Premature baby are risk factor for intracranial haemorrhage.**
INFANTS	• Accidental head injury • Abusive head trauma	• Caused by inappropriate childcare practise • If mechanism of injury is not clear,consider for child abuse. • AHT is the most common cause of TBI related hospitalisation and death
TODDLERS & SCHOOL CHILDREN	• Accidental head injury	• Caused by accidents increase as child develop motor ability • Pedestrian injury also increases In this age group.
ADOLESCENTS	• Bicycle and motorcycle related accidents • Sports related head injuries	• Trainers and players those involved in contact sports will require education about concussion.

Paediatric Traumatic Brain Injury.Neuro MED Chir (Tokyo) 2017 Feb;57(2);82-93



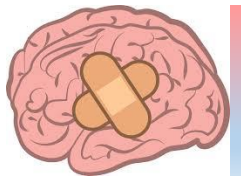
SHAKEN BABY SYNDROME

- Most common cause of NAI/abuse
- Large heavy head
- Weak neck muscle
- Fragile central nervous system



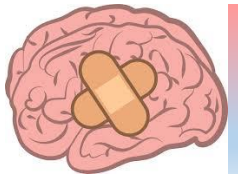
COMMON PRESENTATION

- Lethargy/poor muscle tone
- Decreased appetite,poor feeding/sucking,vomiting
- Extreme irritability
- Grab type bruises on arm or chest
- Seizures
- Difficulty breathing
- Broken bones
- Mental retardation



SUMMARY

- Primary goal of treatment is to prevent secondary brain injury
- Ensure adequate oxygenation and prevent hypotension
- Know the indications for CT brain imaging
- Skull X-ray has no role as diagnostic imaging



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