

# **Management of head trauma in children**

Naji SOUAIBY , MD, MPH, MHM

Wissam EL HAJJ MOUSSA, MD

Lebanon

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**Faculty of  
Medicine  
Montpellier  
France**







**Faculty of Medicine  
St Joseph  
University  
Beirut - Lebanon**







**Byblos the oldest city in the world**

No conflict of interest



1 Y.O girl  
Admitted to the ED  
for Head trauma. Her  
mother  
told you that she felt  
down from a 1 m  
height when her  
sister tried to carry  
her



- Eyes opening and Cries after painful stimuli
- Withdraws to stimuli
- HR: 111/min, RR 25/min, SaO2: 96%, BP: 80/50

Glasgow score ?

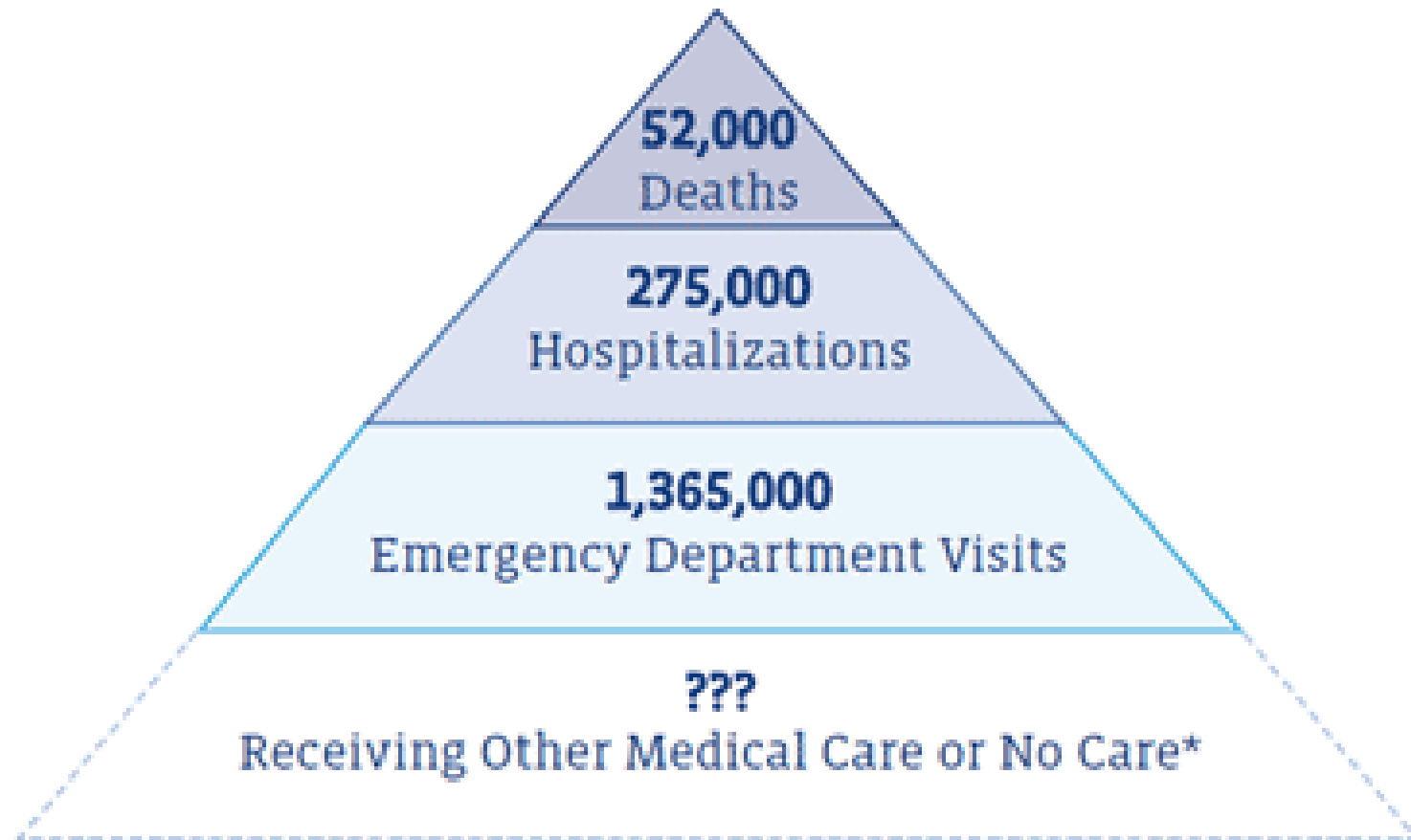
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# INTRODUCTION

- Common cause of admission to the ED
- Cause of death and disability
- Severe head trauma in children under 3 : Child abuse ?
- Key aim management : Prevent or minimize secondary brain injury due to :
  - Hypoxia
  - Poor cerebral perfusion
  - Cerebral bleeding
  - Hypoglycemia
  - Seizures
  - Fever



- 1.7million/Yr in the USA including 0.5 million children; 52,000 people die.



# Physiopathology

- Causes : Falls, sporting accidents, road traffic accidents, and non-accidental injuries
- The skull, face, meninges, and CSF protect the brain
- Forces applied to the head may cause the brain to be :
  - Directly injured
  - Shaken, bouncing against the inner wall of the skull
- As a result :
  - Bleeding
  - Bruise
  - Damage to the nerve connections within the brain

# Steps

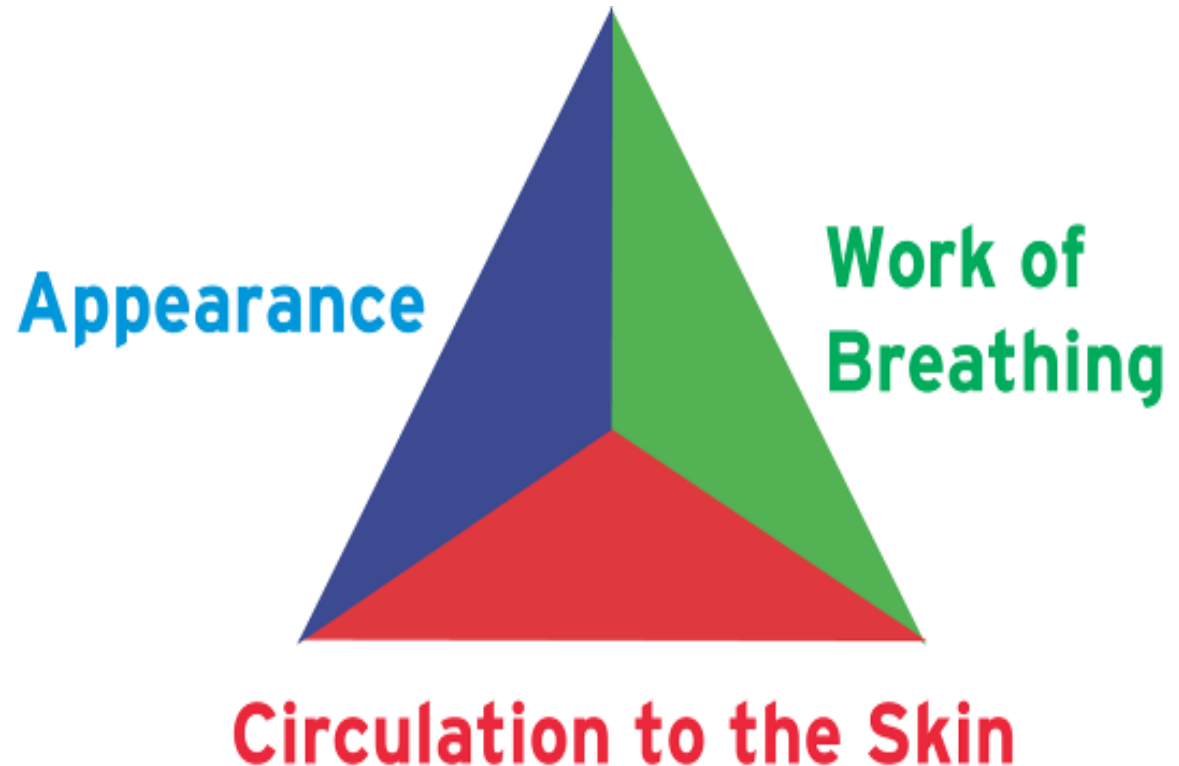
1. Assessment
2. Initial Management
3. Decision in the ED
4. Admission
5. Discharge

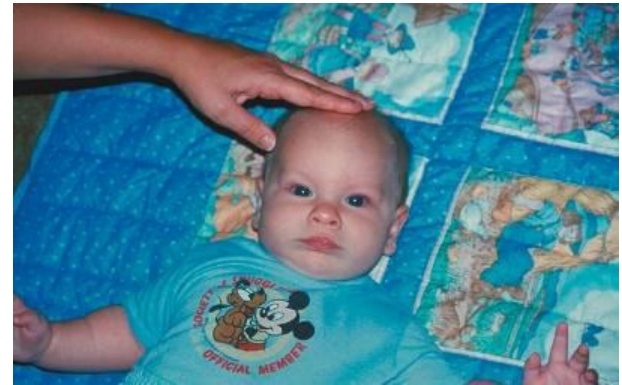


# **Assessment**

# Pediatric Assessment Triangle

- Appearance
  - Awake
  - Aware
  - Upright
- Work of breathing
  - Retractions
  - Noises
- Skin circulation









# Vital Signs by Age

<i>Age</i>	<i>Respirations (breaths/min)</i>	<i>Pulse (beats/min)</i>	<i>Systolic Blood Pressure (mm Hg)</i>
Newborn: 0 to 1 mo	30 to 60	90 to 180	50 to 70
Infant: 1 mo to 1 yr	25 to 50	100 to 160	70 to 95
Toddler: 1 to 3 yr	20 to 30	90 to 150	80 to 100
Preschool age: 3 to 6 yr	20 to 25	80 to 140	80 to 100
School age: 6 to 12 yr	15 to 20	70 to 120	80 to 110
Adolescent: 12 to 18 yr	12 to 16	60 to 100	90 to 110
Older than 18 yr	12 to 20	60 to 100	90 to 140

## Assessment :

- ACB :
  - **A**irway
  - **C**ervical spine
  - **B**reathing and circulation
- Asses the child's mental status using the AVPU scale
  - **A** : Alert
  - **V** : Responds to voice
  - **P** : Responds to pain
    - Purposefully
    - Non-purposefully
      - Withdrawal/flexor response
      - Extensor response
    - **U** : Unresponsive
- Asses pupil size, equality and reactivity

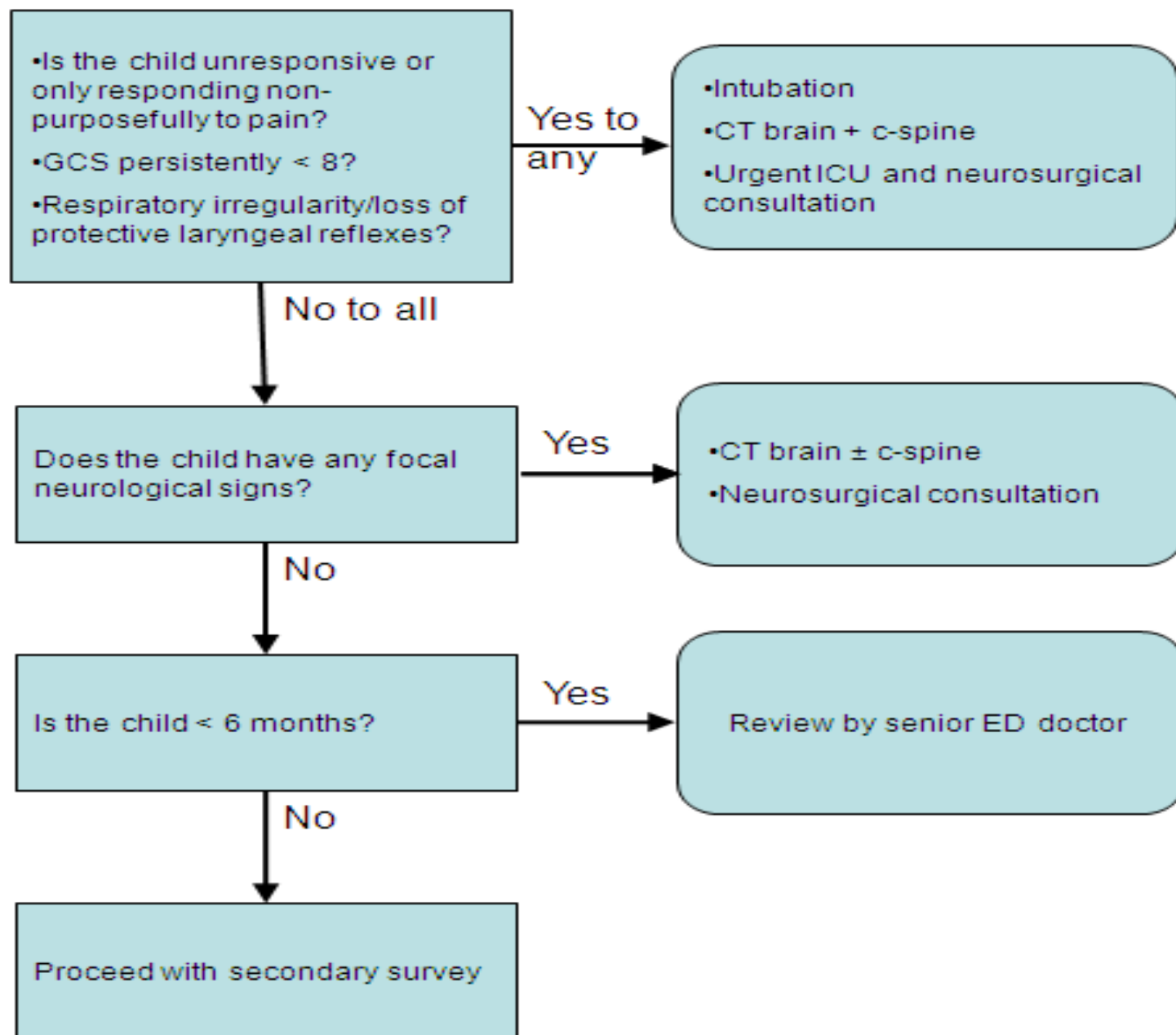


# Glasgow Coma Score (GCS)

> 4 years		<4 years	
Response	Score	Response	Score
<b>Eye opening</b>		<b>Eye opening</b>	
Spontaneously	4	Spontaneously	4
To verbal stimuli	3	To verbal stimuli	3
To painful stimuli	2	To painful stimuli	2
No response to pain	1	No response to pain	1
<b>Best verbal response</b>		<b>Best verbal response</b>	
Orientated and converses	5	Appropriate words or social smile, fixes, follows	5
Confused and converses	4	Cries but consolable; less than usual words	4
Inappropriate words	3	Persistently irritable	3
Incomprehensible sounds	2	Moans to pain	2
No response to pain	1	No response to pain	1
<b>Best motor response</b>		<b>Best motor response</b>	
Obeys verbal commands	6	Spontaneous or obeys verbal commands	6
Localises to stimuli	5	Localises to stimuli	5
Withdraws to stimuli	4	Withdraws to stimuli	4
Abnormal flexion to pain (decorticate)	3	Abnormal flexion to pain (decorticate)	3
Abnormal extension to pain (decerebrate)	2	Abnormal extension to pain (decerebrate)	2
No response to pain	1	No response to pain	1

# Initial management

- Intubation / spine immobilization ?
- CT , XR ?
- Senior ED / Neurosurgeon ?

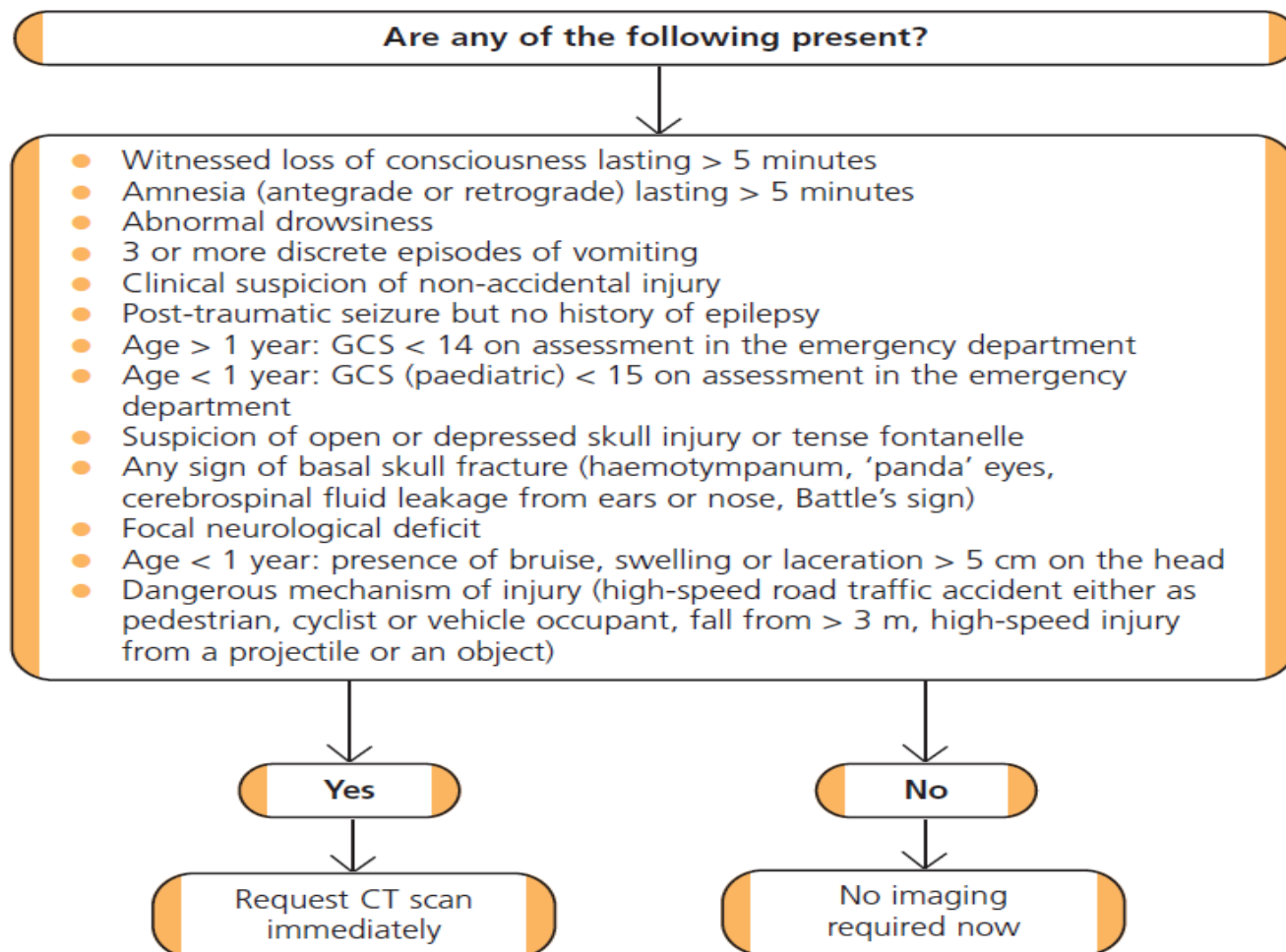


## **Secondary survey ; Features on history**

- Time and mechanism of injury
- Circumstances of injury (e.g accident, fall..)
- Loss or impairment of consciousness and duration
- Nausea and vomiting
- Clinical course prior to ED (Stable, deteriorating, improving)
- Other injuries sustained
- Past history of bleeding tendency



## Selection of children (under 16) for CT scanning of head



## Investigation of non-accidental injury in children

A clinician with expertise in non-accidental injuries in children should be involved in any suspected case of non-accidental injury in a child. Consider: skull X-ray as part of a skeletal survey; ophthalmoscopic examination for retinal haemorrhage; examination for pallor, anaemia, tense fontanelle and other suggestive features. Imaging such as CT and magnetic resonance imaging (MRI) may be required to define injuries.

# Other investigations include :

- Cervical spine imaging
- EKG ( search for arrhythmia as a cause of fall )
- Venous blood gas and blood sugar level (especially in children and in adolescents who have been drinking alcohol)

# How to assess the severity of a head trauma ?

Minor	<ul style="list-style-type: none"><li>- No loss of consciousness</li><li>- Up to one episode of vomiting</li><li>- Stable, alert and conscious state</li><li>- May have scalp bruising or laceration</li><li>- Normal examination otherwise</li></ul>
Moderate	<ul style="list-style-type: none"><li>- Brief loss of consciousness at time of injury</li><li>- Currently alert and responds to voice</li><li>- May be drowsy</li><li>- 2 or more episodes of vomiting</li><li>- Persistent headache</li><li>- Up to one brief convulsion (&lt;2mins) occurring immediately after the impact</li><li>- May have large scalp bruising or laceration</li><li>- Normal examination otherwise</li></ul>
Severe	<ul style="list-style-type: none"><li>- Decreased conscious state – Responsive to pain only or unresponsive</li><li>- Localizing neurological signs (unequal pupils, lateralizing motor weakness)</li><li>- Signs of increased ICP :<ul style="list-style-type: none"><li>• <u>Uncal herniation</u> : Ipsilateral dilated non-reactive pupil (Compression of oculomotor nerve)</li><li>• <u>Central herniation</u> : Brainstem compression causing bradycardia, hypertension, and widened pulse pressure (Cushing's triad)</li><li>• <u>Irregular respirations</u> : Cheyne-Stokes</li><li>• <u>Decorticate</u> : Arms flexed, hands clenched into fists, legs extended, feet turned inward</li><li>• <u>Decerebrate</u> : Head arched back, arms extended by the sides, legs extended, feet turned inward</li></ul></li><li>- Penetrating head injury</li><li>- CSF leak from nose or ears</li></ul>

# When to involve the neurosurgeon ?

- Discuss the care of all patients with new, surgically significant abnormalities on imaging
- Other reasons :
  - Persistent GCS  $< 8$  after initial resuscitation
  - Unexplained confusion for more than 4 hours
  - Deterioration in GCS after admission (Motor response deterioration ++)
  - Progressive focal neurological signs
  - Seizure without full recovery
  - Definite or suspected penetrating injury
  - CSF leak



# Indications for intubation and ventilation

Circumstances	Action
<ul style="list-style-type: none"><li>• Coma – GCS <math>\leq 8</math> (pediatric scale for children)</li><li>• Loss of protective laryngeal reflexes</li><li>• Ventilatory insufficiency<ul style="list-style-type: none"><li>- Hypoxemia / Hypercapnia</li></ul></li><li>• Irregular respirations</li></ul>	<ul style="list-style-type: none"><li>• Intubate and ventilate immediately</li></ul>
<ul style="list-style-type: none"><li>• Significantly deteriorating conscious level (1 or more points on motor score), even if not coma</li><li>• Unstable fractures of the facial skeleton</li><li>• Copious bleeding into mouth</li><li>• Seizures</li></ul>	<ul style="list-style-type: none"><li>• Intubate and ventilate before you start your journey</li></ul>

# **Decision in the ED**

## **A) Minor head injury**

- May be discharged from the ED to the care of their parents
- If there is any doubt as to whether there has been loss of consciousness or not, assume there has been and treat as for moderate head injury
- Adequate analgesia

## **B) Moderate head injury**

- History → No neurological deterioration

**Observation in the ER** > 4 hours with neurological observations

(Conscious state, PR, RR, BP, pupils and limbs power )

- Discharge home if there is improvement to normal conscious state, no further vomiting and child able to tolerate oral fluids
- A persistent headache, large hematoma or possible penetrating wound may need further investigation
- Adequate analgesia
- Anti-emetics, but consider a longer period of observation if anti-emetics are given



## **C) Severe head injury**

- The initial aim of management is to **prevent secondary brain damage**
- The key aims are :
  - Maintain oxygenation, ventilation and circulation
  - Avoid rises in intracranial pressure
- Urgent CT of head and cervical spine. Ensure early neurosurgical and ICU intervention
- Cervical spine immobilization should be maintained even if cervical spine imaging is normal
- Intubation and ventilation (as seen above)

## Consider measures to decrease intracranial pressure :

- Nurse 20-30 degrees head up (after correction of shock) and head in midline position to help venous drainage
  - Ventilate to a pCO<sub>2</sub> 35-40 mmHg (4-4,5 kPa)
  - Ensure adequate blood pressure with crystalloid infusion or inotropes (e.g noradrenaline) if necessary
  - Consider mannitol (0,5-1 g/kg IV over 20-30 min) or hypertonic saline (NaCl 3% 3ml/kg IV over 10-20 mins)
  - Consider Phenytoin loading dose (20mg/kg IV over 20 mins)
  - Control seizures
  - Correct hypoglycemia
  - Analgesia: Sufficient analgesia should be administered by careful titration
- N.B : Head injured children are often more sensitive to opioids

## **Observation**

- Perform and record observations on a half-hour basis until GCS = 15
- When GCS = 15, minimum frequency of observation is
  - Every 30 minutes for 2 hours
  - Every hour for 4 hours
  - Then every 2 hours thereafter
- If patient deteriorates to GCS < 15 after initial 2-hour period, revert to half-hourly observations and follow original schedule
- Minimum acceptable documented neurological observations :
  - GCS (adult or paediatric, limb movements)
  - Respiratory rate
  - Temperature
  - Pupil size and reactivity
  - Heart rate
  - Blood oxygen saturation

# **Admission**



## **Criteria for admission of a patient with head trauma :**

- New, clinically significant abnormalities on imaging
- Not returned to GCS 15 after imaging, regardless of the imaging results
- Criteria for CT scan fulfilled, but scan not done within appropriate period, either because CT scan is not available, or because the patient is not sufficiently co-operative to allow scanning
- Continuing worrying signs (e.g persisting vomiting, severe headache)
- Other sources of concern (e.g drug or alcohol intoxication, other injuries present, shock, suspected non-accidental injury, meningism, CSF leak)

## Patient changes requiring review

### Have any of the following happened?

- Agitation or abnormal behaviour developed
- GCS dropped by 1 point and lasted for at least 30 minutes (give greater weight to a drop of 1 point in the motor response score)
- Any drop of 3 or more points in the eye-opening or verbal response scores, or 2 or more points in the motor response score
- Severe or increasing headache developed or persistent vomiting
- New or evolving neurological symptoms or signs, such as pupil inequality or asymmetry of limb or facial movement

Yes

Is a second member of staff competent to perform observation available immediately?

No

Urgent reappraisal by supervising doctor

Change confirmed?

Yes

Consider immediate CT scan, re-assess patient's clinical condition and manage appropriately

Yes

Change confirmed?

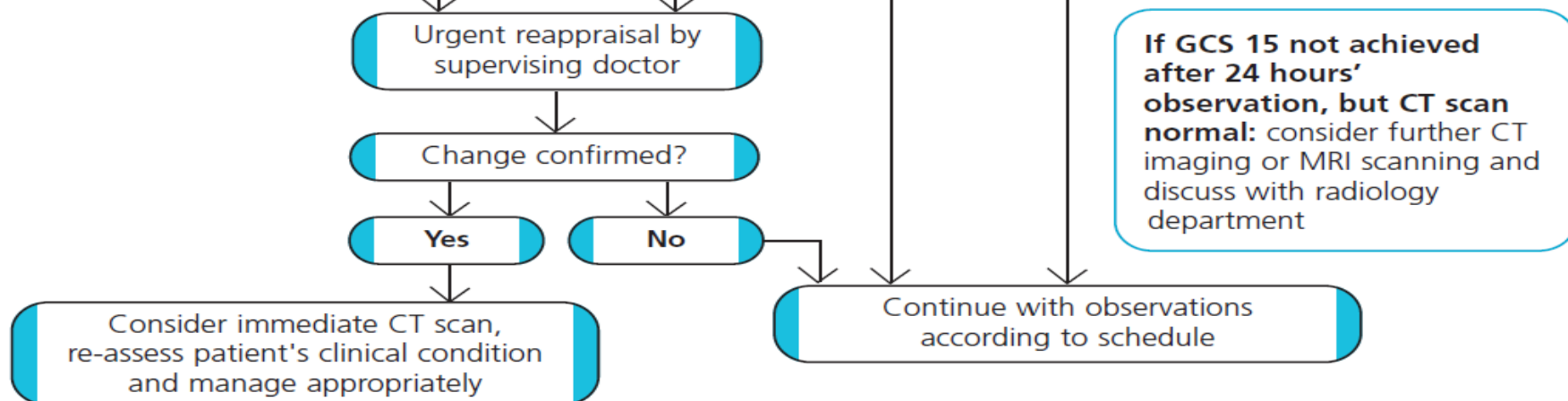
Yes

No

Continue with observations according to schedule

No

If GCS 15 not achieved after 24 hours' observation, but CT scan normal: consider further CT imaging or MRI scanning and discuss with radiology department



**Discharge**

- Do not discharge any child who presents with a head injury until GCS = 15
- For infants, normal consciousness as assessed by the pediatric Glasgow Coma Scale should be achieved before discharge

## **General advices upon discharge**

- Clear instructions to return immediately to the hospital if the patient :
  - Becomes unconscious or difficult to rouse
  - Becomes confused
  - Develops a persistent headache
  - Vomits more than once
  - Develops any bleeding or watery discharge from the ears or nose

## Specific groups

- **No care at home**, allow discharge
  - If suitable supervision arrangements have been organized
  - When the risk of late complications is deemed negligible
- **Low risk, CT not done, GCS = 15**, allow discharge
  - If CT not indicated from history and examination
  - If no other factors warrant admission
  - If there are appropriate support structures for safe transfer and subsequent care
- **Normal imaging of the head**, allow discharge
  - If patient has returned to GCS = 15
  - If no other factors warrant admission
  - If there are appropriate support structures for safe transfer and subsequent care.



- **Normal imaging of the cervical spine**, allow discharge
  - If patient has returned to GCS = 15
  - If no other factors warrant admission
  - If there are appropriate support structures for safe transfer and subsequent care
- **Admitted for observation**, allow discharge
  - After resolution of all significant symptoms and signs
  - If suitable home supervision arrangements exist
  - Unless the patient was admitted out of hours and requires a CT scan the following morning
- **At risk of non-accidental injury**
  - Do not discharge an infant or a child with a head injury that required imaging of the head or cervical spine, until an experienced clinician in the detection of non-accidental injuries has examined him/her

- **If a patient returns to the emergency department within 48 hours of discharge with persistent complaint relating to initial injury, involve a senior clinician with experience in head injuries and consider CT scan**

THANK YOU

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