Traumatic Brain Injury

Initial Resuscitation, Prehospital Care, and Emergency Department Care in Traumatic Brain Injury

- Pre-hospital care
- Primary survey
- Secondary survey
- Investigation consideration
- Acute phase management in TBI

Pre-hospital management

Pre-hospital management

- Rapid removal of the accident victim to a trauma care facility is critical to improve the chances of survival
- Secure the scene and remove the patient safely without causing other injury
- BLS and ALS are 2 important roles “scoop and run”
- Pre-hospital management plays a significant role in decreasing mortality rate

TBI guidelines for pre-hospital management

BOX 386.1 Guidelines for Prehospital Management of Traumatic Brain Injury

I. Assessment: oxygenation and blood pressure
   Monitor oxygen saturation and blood pressure continuously.
   Avoid hypoxemia (<90% O_2 saturation) and hypotension (<90 mm Hg systolic blood pressure).
II. Assessment: GCS score
   Use as a reliable indicator of severity of traumatic brain injury and also for prognosis.
   Obtain after securing airway, breathing, and circulation.
   Obtain before administering sedatives or paralytics.
   Obtain using trained personnel by interacting with the patient.
III. Assessment: pupil examination
   Assess in the field for use in diagnosis and prognosis.
   Note evidence of orbital trauma.
   Assess after resuscitation and stabilization.
   Record bilateral pupillary size and reflex.
IV. Treatment: airway, ventilation, and oxygenation
   Establish an airway with supplemental oxygen in patients who have severe brain injury, inability to maintain an airway, or hypoxemia.
   Avoid hypoxemia (SpO_2 <90%).
   Monitor blood pressure, oxygenation, and $ETCO_2$ while implementing endotracheal intubation protocols.
   Confirm the position of the endotracheal tube by auscultation and $ETCO_2$ determination.
   Avoid hyperventilation ($ETCO_2$ >35 mm Hg) unless patient shows evidence of cerebral herniation.
   In ground transportation in an urban environment, routine use of paralytics is not recommended for intubating adult patients who are spontaneously breathing and maintaining SpO_2 above 90%.
V. Treatment: fluid resuscitation
   Treat hypotensive patients with isotonic fluids.
VI. Treatment: cerebral herniation
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   In patients who are normoventilated, well oxygenated, and normotensive, hyperventilation can be used as a temporizing measure to keep $ETCO_2$ between 30 and 35 mm Hg. If used, administer hyperventilation at 20 breaths/min in an adult, 25 breaths/min in a child, and 30 breaths/min in an infant

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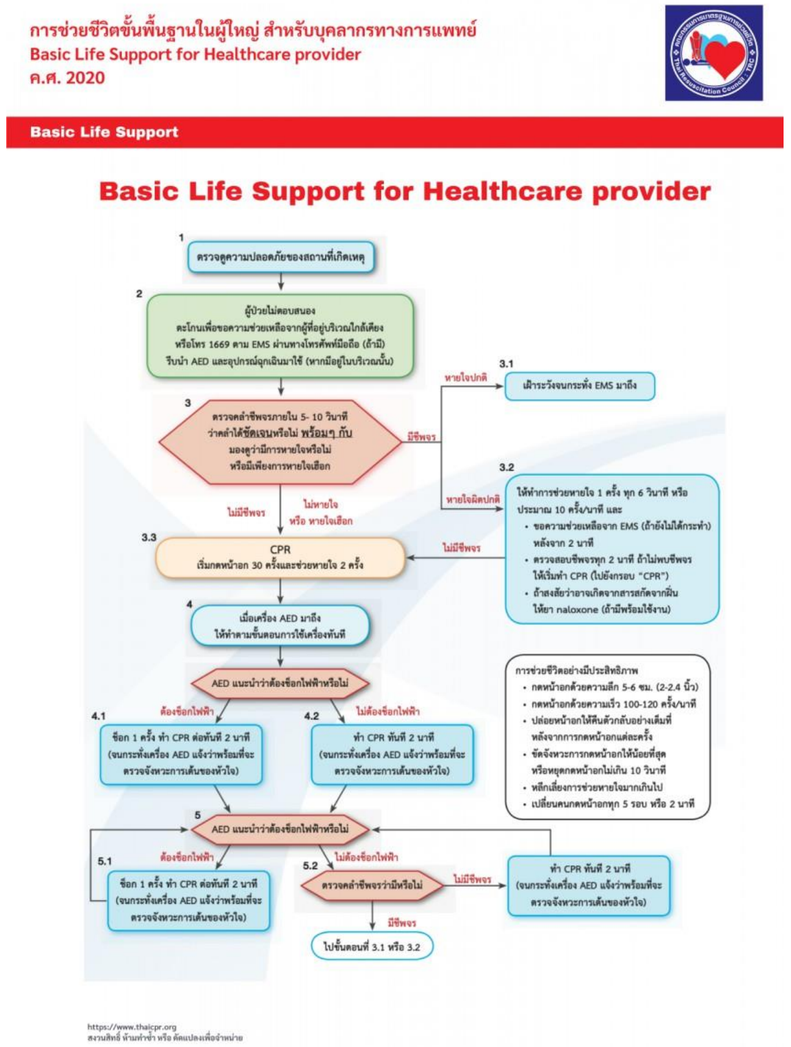

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- Assessment
  - Airway
  - Breathing
  - Circulation
  - Disability

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Assessment

- Oxygenation and blood pressure
  - Assessing Airway, Breathing, Circulation
  - Airway obstruction
  - Avoid hypoxemia (< 90% O2 sat)
  - Avoid hypotension (SBP < 90 mmHg)

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Assessment

- GCS score
  - After securing ABC
  - Before sedative

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Assessment

- Pupil examination
  - Size
  - Reflex
  - Trauma

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Treatment

- Airway, Breathing
  - Intubation in patient GCS < 8
  - ETCO2 monitoring (avoid hyperventilation (ETCO2 > 35 mmHg)
  - Avoid hypoxemia (< 90% O2sat)
  - C-spine protection, Philadelphia collar

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Treatment

- Circulation
  - Fluid resuscitation
  - Isotonic saline
- Patient with hypotension have twice the mortality rate

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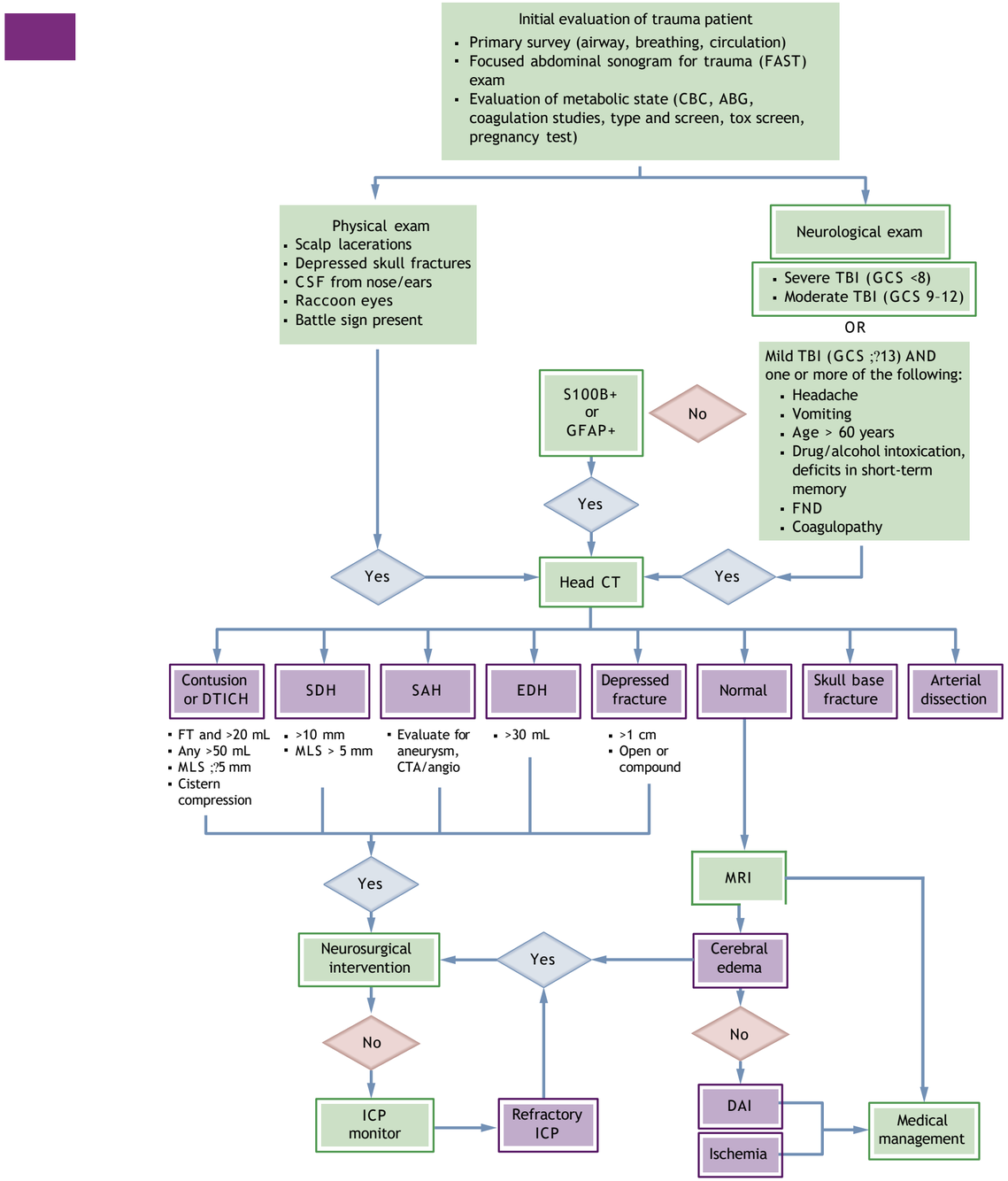
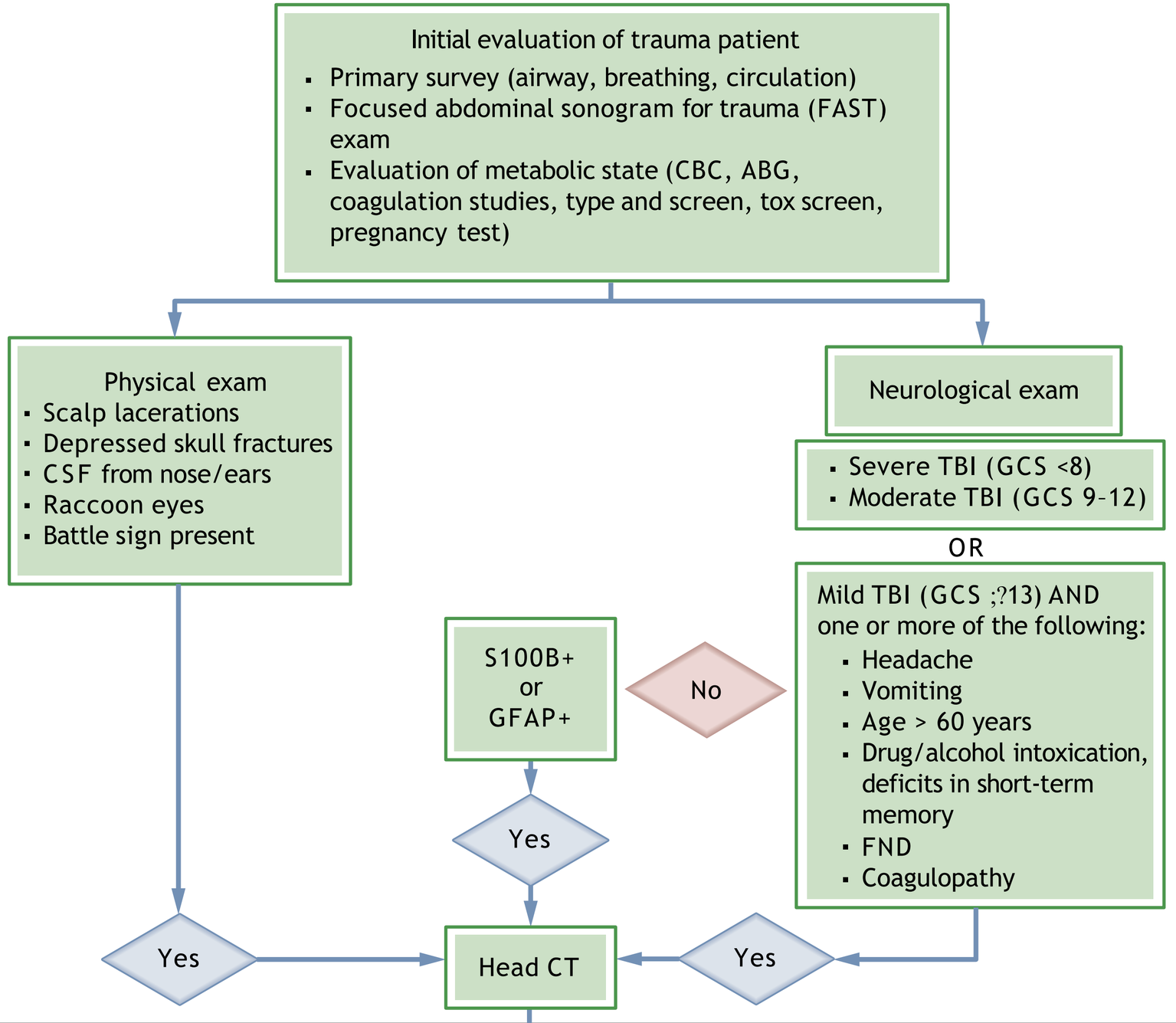
Treatment

- Disability
  - Avoid mild or prophylactic hyperventilation ($PaCO2 < 35$ mmHg)
  - Monitor signs of herniation
    - Asymmetrical, dilated, nonreactive pupils
    - Decelebrate posture

In-Hospital Care


Initial evaluation of trauma patient
Primary survey (airway, breathing, circulation)
Focused abdominal sonogram for trauma (FAST) exam
Evaluation of metabolic state (CBC, ABG, coagulation studies, type and screen, tox screen, pregnancy test)
Physical exam
Scalp lacerations
Depressed skull fractures
CSF from nose/ears
Raccoon eyes
Battle sign present
Neurological exam
Severe TBI (GCS <8)
Moderate TBI (GCS 9-12)
OR
Mild TBI (GCS ;?13) AND one or more of the following:
Headache
Vomiting
Age > 60 years
Drug/alcohol intoxication, deficits in short-term memory
FND
Coagulopathy
S100B+ or GFAP+
No
Yes
Yes
Head CT
Yes
Contusion or DTICH
SDH
SAH
EDH
Depressed fracture
Normal
Skull base fracture
Arterial dissection
FT and >20 mL
Any >50 mL
MLS ;?5 mm
Cistern compression
>10 mm
MLS > 5 mm
Evaluate for aneurysm, CTA/angio
>30 mL
>1 cm
Open or compound
Yes
MRI
Neurosurgical intervention
Yes
Cerebral edema
No
No
ICP monitor
Refractory ICP
DAI
Ischemia
Medical management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Head CT

Primary Survey

BOX 386.2 Primary Survey

AIRWAY

1. Assess the airway, and determine its adequacy.
2. Create or maintain an airway.
3. Recognize the potential for cervical spine injury, and maintain the spine in a safe, neutral position.

BREATHING

1. Administer high-flow oxygen.
2. Assess the chest for injuries.
3. Recognize and treat:
   a. Tension pneumothorax
   b. Massive hemothorax
   c. Flail chest
   d. Sucking chest wounds
   e. Pericardial tamponade

CIRCULATION

1. Assess circulation by:
   a. Looking for external hemorrhage
   b. Observing skin color, temperature, and capillary refill
   c. Feeling the pulse
   d. Recording blood pressure
   e. Assessing neck veins

DISABILITY

1. Assess the Glasgow Coma Scale score.
2. Assess pupillary size and response.
3. Examine for lateralizing signs and signs of cord injury.

EXPOSURE

1. Expose the patient so an adequate complete examination can be performed.
2. Prevent hypothermia.

Airway

- Initially evaluated
- Ensure patients have unobstructed airway
- Cervical spine protection, neutral position
- Nasal airway should be avoided if there is concern for facial or sinus fractures

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Breathing

- Symmetrical chest wall movement, injuries
- Recognizing threat

- An arterial CO2 of 35 to 40 mm Hg should be targeted
- CBF increase by 2-4% for each unit of elevation of CO2 -> Increase ICP

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Circulation

- External hemorrhage
- Signs of shock, intravascular volume - skin color, capillary refill, neck veins
- Loss of auto regulation in the cerebral circulation 30-50% of case
  -> Increase ICP -> Cushing response
  -> Sensitive to hypotension
  (↓↓ CPP=↓MAP-↑ICP)
- TBI, Spinal cord injury -> Neurogenic shock (Hypotension with bradycardia)
  Tx. with pressor + aggressive volume expansion

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Disability

- GCS score
- Pupillary size
- Simplified neurological exam, cranial n.
- Reflexes

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Exposure

- Completely exposed to identify wounds, deformities
- Log-roll technique
- Prevent hypothermia

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Secondary Survey

Secondary Survey

- History
- Examination
- Investigation

Secondary Survey

History - AMPLE

- A - Allergy
- M - Medication (Antithrombotic, antiplatelets)
- P - Past history (Underlying disease, pregnancy)
- L - Last meal
- E - Events (Mechanism of trauma, speed, vehicle type, seizure activity)

Secondary Survey

Examination

- Head to toe examination
- System specific examination
- Detailed neurological assessment

Secondary Survey

Detailed neurological examination

TABLE 387.1 Glasgow Coma Scale for Assessment of Coma and Impaired Consciousness

Eye Opening	Best Motor Response	Best Verbal Response
4 = Spontaneous	6 = Obeying	5 = Oriented
3 = To speech	5 = Localizing	4 = Confused
2 = To pain	4 = Withdrawing or Normal Flexing	3 = Inappropriate
1 = None	3 = Abnormal Flexing	2 = Incomprehensible
	2 = Extending	1 = None
	1 = None	

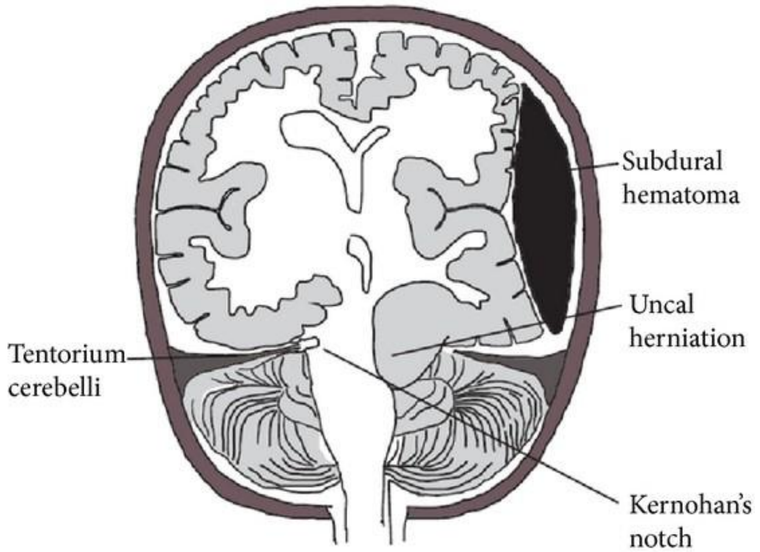
Data from Teasdale G, Jennett B. Assessment of coma and impaired consciousness. A practical scale. Lancet. 1974;2:81–84.

- **GCS**
  - Useful in communicating patient's level of consciousness over time
  - Hypotensive , pharmacologically paralyzed →hinders correct scoring
  - Pre/Post resuscitation GCS should be obtained
  - Best response should be noted
  - Deterioration of GCS score calls for attention and require management

Secondary Survey

Detailed neurological examination

- **Pupillary examination** - Great prognostic factor, can be easily re-examine
  - Eye trauma
  - Unilateral dilated pupil should be considered to be caused by ipsilateral uncle herniation
  - RAPD positive may indicate optic n. Injury
  - Bilateral dilated pupil may result from hypoxia, hypotension, drugs, bilateral third n. dysfunction (Infero-lateral eye deviated)
  - Kernohan phenomenon - ipsilateral pupillary dilatation and ipsilateral hemiparesis due to contralateral cerebral peduncle that is pushed against tentorial cerebelli



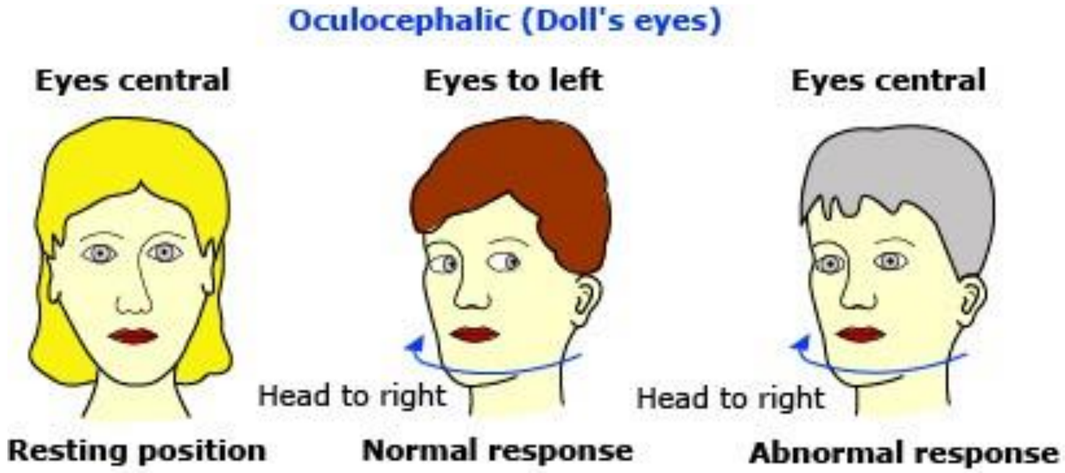
Secondary Survey

Detailed neurological examination

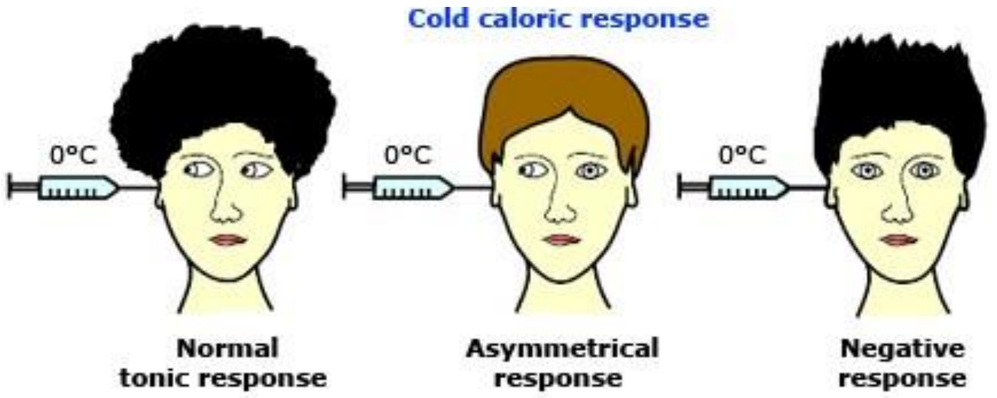
- **Head examination**
  - Entrance wound or large laceration
  - Foreign bodies, bony step-offs
  - Blood or CSF otorrhea
  - Battle sign - posterior basilar skull fracture
  - Raccoon eyes - anterior skull base fracture

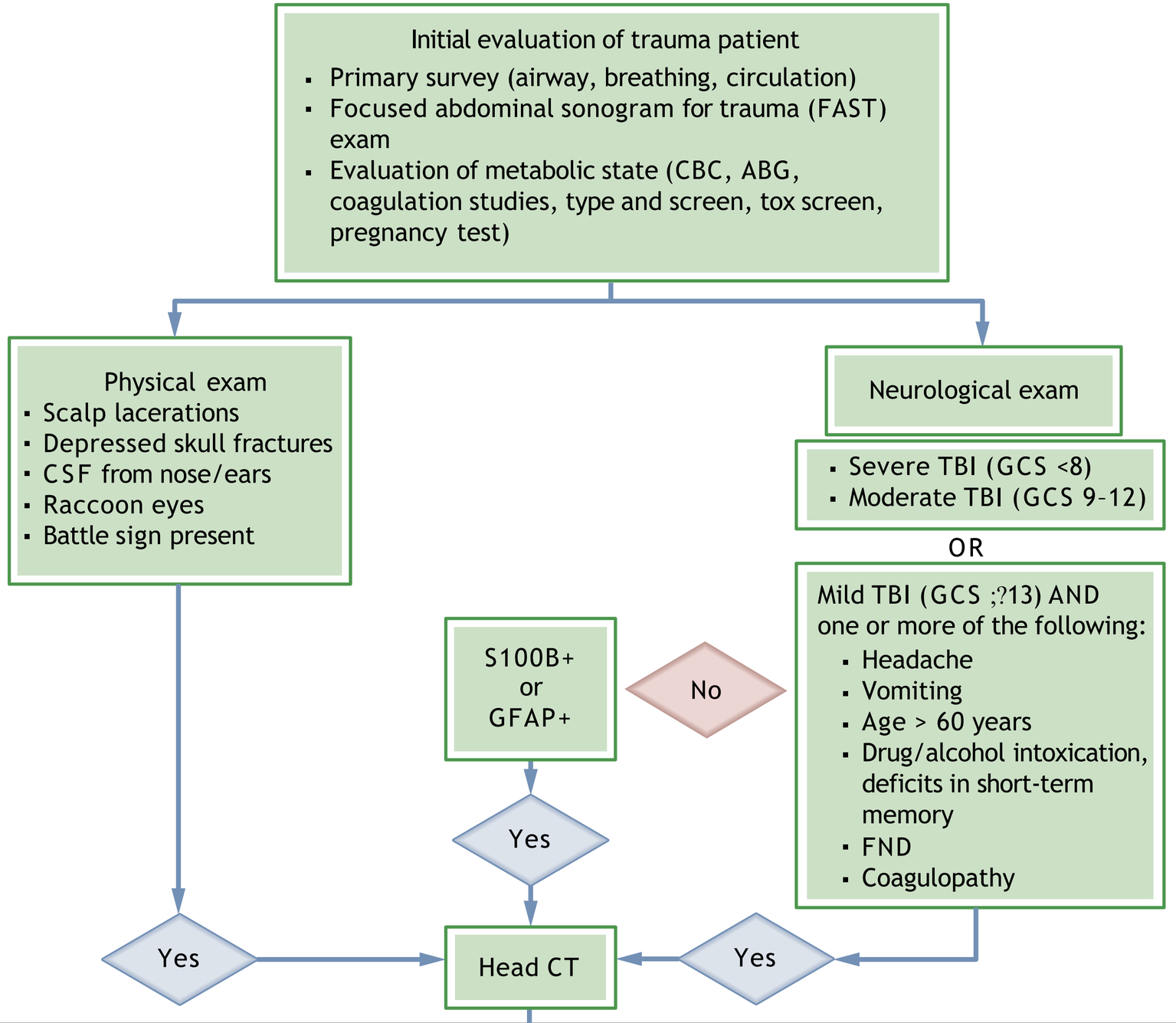
Secondary Survey

Detailed neurological examination



- **Reflexes**
  - DTR are not reliable
  - Oculocephalic reflex (Doll's eye) - should beware of C-spine injury suggest intact tegmental structures in pons and midbrain
  - Cold caloric test - Irrigate ear canal with 30 ml of ice water -> eyes deviate toward side being stimulated

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Head CT

Secondary Survey

Investigation

- Computed Tomography (CT) Brain
  - ATLS guideline suggest a goal of 30 minutes between assessment and CT
  - Indication
    - Moderate to severe TBI (GCS </= 12)

Secondary Survey

Investigation

- Computed Tomography (CT)
  - Mild TBI (GCS >/= 13)
  - S100B or GFAP positive

Level A: A noncontrast head CT is indicated in head trauma patients with loss of consciousness or posttraumatic amnesia only if one or more of the following is present:

- Headache
- Vomiting
- Age >60 years
- Drug or alcohol intoxication
- Deficits in short-term memory
- Physical evidence of trauma above the clavicle
- Posttraumatic seizure
- GCS score <15
- Focal neurologic deficit
- Coagulopathy

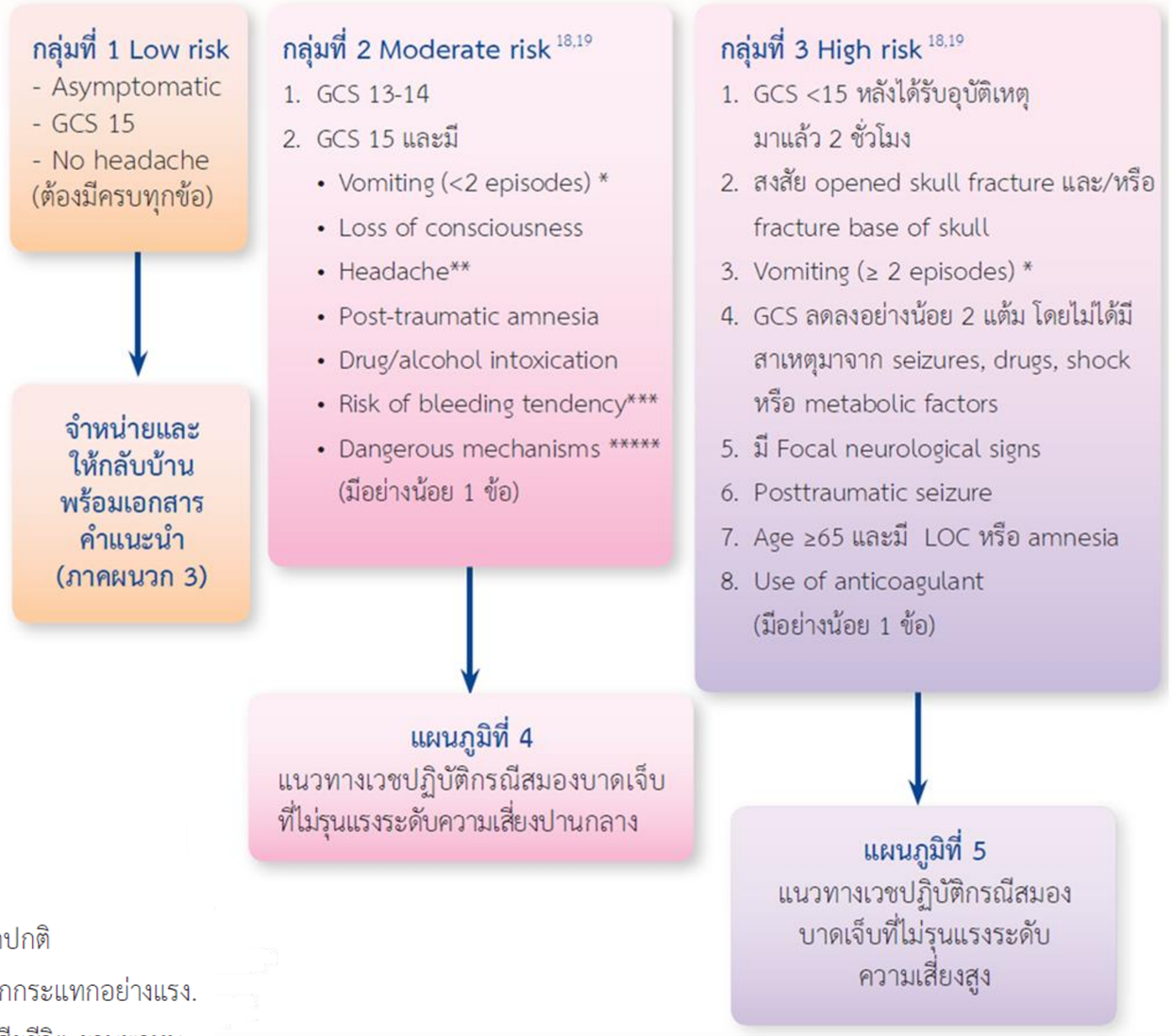
Level B: A noncontrast head CT should be considered in head trauma patients with no loss of consciousness or posttraumatic amnesia if one or more of the following are present:

- Severe headache
- Vomiting
- Age >65 years
- Physical signs of a basilar skull fracture
- GCS score <15
- A focal neurologic deficit
- Coagulopathy
- A dangerous mechanism of injury (motor vehicle accident, pedestrian struck, fall from >3 feet or 5 steps)

Secondary Survey

Investigation

- Computed Tomography (CT)
  - Low risk
  - Moderate risk
  - High risk

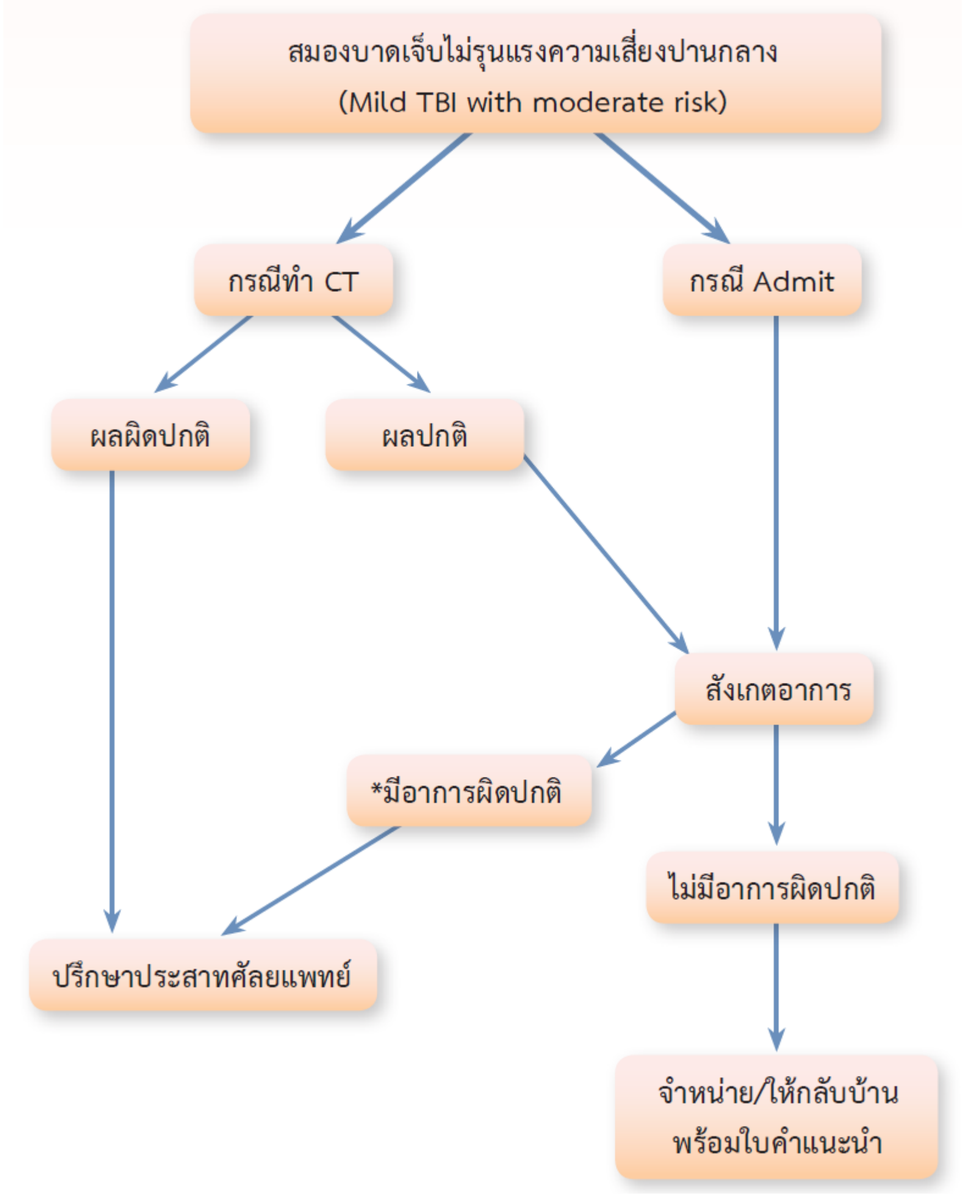


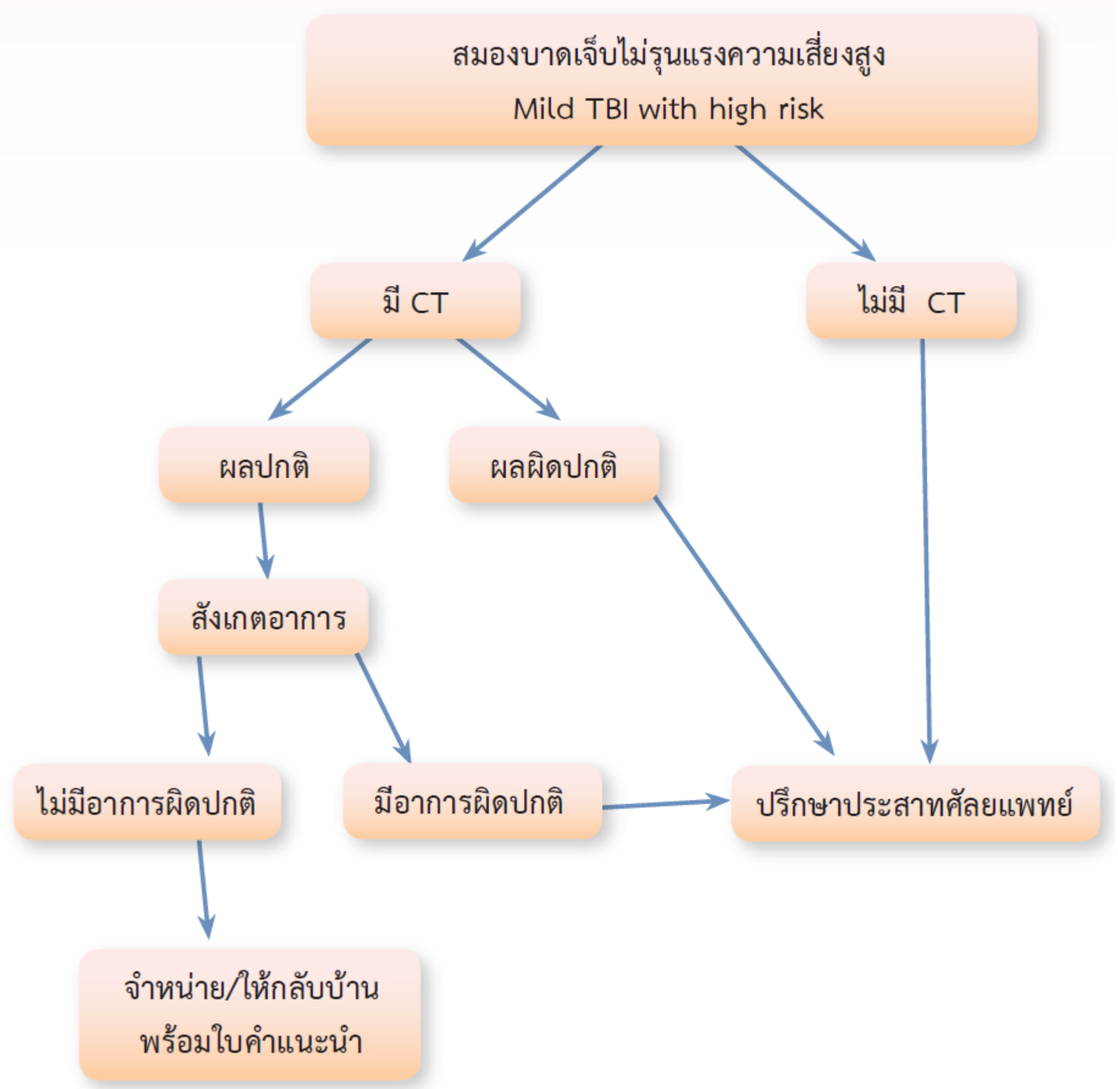
* Vomiting episode หมายถึง การอาเจียนแต่ละครั้งมีระยะห่างพอสมควร

** headache ไม่รวมถึงการเจ็บหรือปวดเฉพาะที่ของบาดแผล

*** Risk of bleeding tendency เช่น ใช้ยากลุ่ม antiplatelet, โรคที่ทำให้มีเลือดออกง่ายผิดปกติ

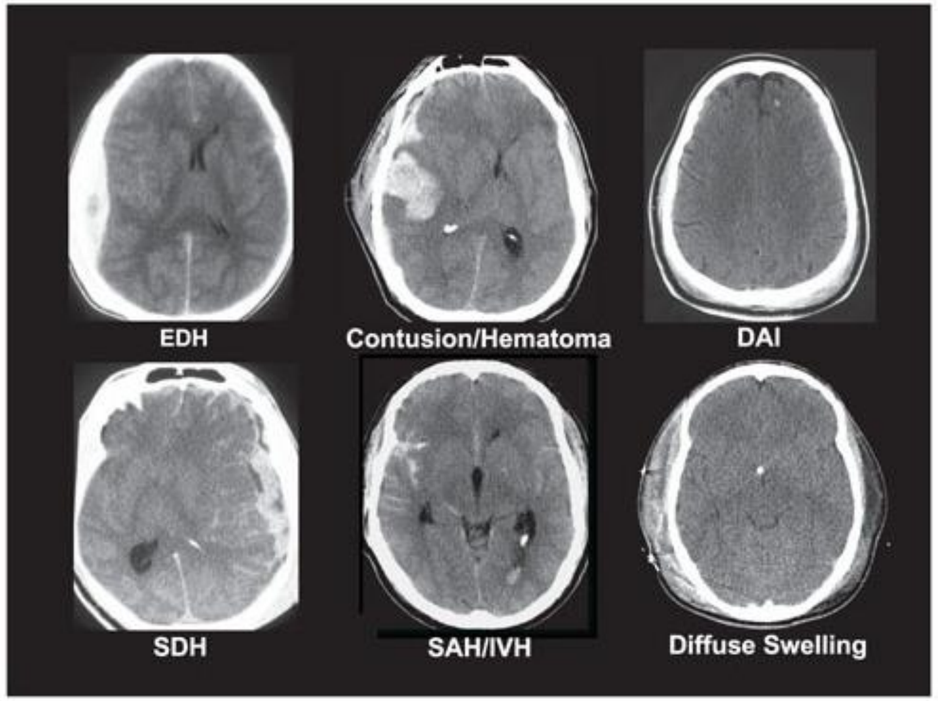
**** Dangerous mechanism หมายถึง ตกจากที่สูงมากกว่า 0.9 เมตร หรือ 3 ฟุต, ศีรษะถูกกระแทกอย่างแรง. อุบัติเหตุจากมอเตอร์ไซด์, อุบัติเหตุจราจรที่ผู้ป่วยกระเด็นออกจากยานพาหนะ มีผู้โดยสารอื่นเสียชีวิต ยานพาหนะพลิกคว่ำ ถูกรถชนในขณะเดินถนน


สมองบาดเจ็บไม่รุนแรงความเสี่ยงปานกลาง
(Mild TBI with moderate risk)
กรณีทำ CT
กรณี Admit
ผลผิดปกติ
ผลปกติ
สังเกตอาการ
*มีอาการผิดปกติ
ไม่มีอาการผิดปกติ
ปรึกษาประสาทศัลยแพทย์
จำหน่าย/ให้กลับบ้าน
พร้อมใบคำแนะนำ


สมองบาดเจ็บไม่รุนแรงความเสี่ยงสูง
Mild TBI with high risk
มี CT
ไม่มี CT
ผลปกติ
ผลผิดปกติ
สังเกตอาการ
ไม่มีอาการผิดปกติ
มีอาการผิดปกติ
ปรึกษาประสาทศัลยแพทย์
จำหน่าย/ให้กลับบ้าน
พร้อมใบคำแนะนำ

Secondary Survey

Investigation



- Computed Tomography (CT) Brain
  - Finding
    - Acute hemorrhage
    - Associated mass effect
    - Loss of cistern, loss attenuation of gray-white junction
    - Ventricular system - hydrocephalus, midline shift
    - Skull fractures

Secondary Survey

Investigation

- Computed Tomography (CT) C-Spine
  - Still lack of consensus regarding efficient and effectiveness
  - Patient with evidence of neurological deficit, intoxication, distracting injury should undergo CT C-spine

Secondary Survey

Investigation

- Plain radiographs
  - Used to play an important role before the widespread availability of CT scan
  - Useful for fractures, penetrating injuries, radiopaque foreign body

Secondary Survey

Investigation

- MRI
  - Not for acute phase of head trauma due to time requirement to scan
  - May be useful in TBI once patient is stabilized
  - Identify early cerebral edema, DAI, ischemic events
  - MR angiography is helpful in evaluating arterial injuries, dissection, occlusion
  - Bony details are more difficult to evaluate

Secondary Survey

Investigation

- Cerebral angiography
  - Gold standard for assessing vasculature
  - CTA may be more suitable in acute phase
  - Endovascular management

Management

Management

- Mild TBI
- Moderate and severe TBI

Management

Mild TBI

- GCS 13-15
- CT scan or not
- Mild TBI and negative CT scans can be safely discharged
- Others with contusion or hemorrhages but with GCS score of 14-15, or active ongoing anti platelet or anti coagulant should be observe for 24-48 hrs
- Beware of lucid interval

Management

Moderate and Severe TBI

- Airway - Intubation ?
  - Hypoxia ($PaO_2 < 60$ mmHg) correlates with poor outcome
- Breathing - Hyperventilation ?
  - $PaCO_2 < 35$
- Circulation - Maintain SBP above 100 mmHg
  - Fluid resuscitation
  - Vasopressor (Hypotension without tachycardia)

Management

Moderate and Severe TBI

- “Control of ICP” is the goal of acute trauma management
  - ICP monitoring is recommended in patients with GCS </= 8
  - ICP greater than 20 mmHg correlates with increased mortality
- Mannitol
  - 0.5-1.4g/kg in hemodynamically stable
  - Serum osmolality should be maintained below 320 mOsm/kg
  - Foley catcher and volume replacement

Management

Moderate and Severe TBI

- Hypertonic saline
  - 150 ml of 3%Nacl or 30 ml of 23%NaCl
  - Continuous infusion to maintain serum Na 150-160
  - Risk of hyperchloremic metabolic acidosis

Management

Moderate and Severe TBI

- Prevention of seizures (negative prognostic indicator in TBI)
  - Anti-epileptic drug is only recommended in first week after injury
  - Risk of hypotension

Management

Conclusion

- Preventing hypoxia
- Maintaining eucapnia or mild hypocapnia
- Preventing hypotension
- Controlling ICP
- Decompressing mass lesion

Thank you