CLINICAL PRACTICE GUIDELINES

DECEMBER 2015 MOH/P/PAK/XXX (GU)

EARLY MANAGEMENT OF HEAD INJURY IN ADULTS

Ministry of Health Malaysia

Neurosurgical Association of Malaysia

Academy of Medicine Malaysia

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STATEMENT OF INTENT

These clinical practice guidelines (CPG) are meant to be guides for clinical practice, based on the best available evidence at the time of development. Adherence to these guidelines may not necessarily guarantee the best outcome in every case. Every healthcare provider is responsible for the management of his/her unique patient based on the clinical picture presented by the patient and the management options available locally.

REVIEW UPDATE

These guidelines were issued in 2015 and will be reviewed in a minimum period of four years (2019) or sooner if new evidence becomes available. When it is due for updating, the Chairman of the CPG or National Advisor of the related specialty will be informed about it. A discussion will be done on the need for a revision including the scope of the revised CPG. A multidisciplinary team will be formed and the latest systematic review methodology used by MaHTAS will be employed.

TABLE OF CONTENTS

LEVELS OF EVIDENCE

Level	Study design
I	Evidence from at least one properly randomised controlled trial
II -1	Evidence obtained from well-designed controlled trials without randomisation
II-2	Evidence obtained from well-designed cohort or case-control analytic studies, preferably from more than one centre or group
II-3	Evidence from multiple time series with or without intervention. Dramatic results in uncontrolled experiments (such as the results of the introduction of penicillin treatment in the 1940s) could also be regarded as this type of evidence
III	Opinions of respected authorities based on clinical experience; descriptive studies and case reports; or reports of expert committees

SOURCE: US / CANADIAN PREVENTIVE SERVICES TASK FORCE 2001

In line with the current development in CPG methodology, the CPG Unit of MaHTAS is in the process of adapting **Grading Recommendations, Assessment, Development and Evaluation (GRADE)** in its work process. The quality of each retrieved evidence and its effect size are carefully assessed/reviewed by the CPG Development Group. In formulating the recommendations, overall balances of the following aspects are considered in determining the strength of the recommendations:-

- overall quality of evidence
- balance of benefits versus harms
- values and preferences
- resource implications
- equity, feasibility and acceptability

GUIDELINES DEVELOPMENT AND OBJECTIVES

GUIDELINES DEVELOPMENT

The members of the Development Group (DG) for this Clinical Practice Guidelines (CPG) were from the Ministry of Health (MoH) and Ministry of Education. There was active involvement of a multidisciplinary Review Committee (RC) during the process of the CPG development.

A literature search was carried out using the following electronic databases: Guidelines International Network (G-I-N), Medline via Ovid, Pubmed and Cochrane Database of Systemic Reviews (CDSR) (refer to **Appendix 1** for **Example of Search Strategy**). The search was limited to literature published in the last ten years, on humans and in English. In addition, the reference lists of all retrieved literature and guidelines were searched to further identify relevant studies. Experts in the field were also contacted to identify further studies. All searches were conducted from 5 January 2014 to 9 July 2014. Literature searches were repeated for all clinical questions at the end of the CPG development process allowing any relevant papers published before 31 August 2015 to be included. Future CPG updates will consider evidence published after this cut-off date. The details of the search strategy can be obtained upon request from the CPG Secretariat.

References were also made to other CPGs on Head Injury such as Scottish Intercollegiate Guidelines Network (SIGN)-Early management of patients with a head injury (2009) and National Institute for Health and Clinical Excellence (NICE)-Head injury: Triage, assessment, investigation and early management of head injury in infants, children and adults (2014).The CPG was evaluated using the Appraisal of Guidelines for Research and Evaluation (AGREE) II prior to them being used as references.

A total of 28 clinical questions were developed under different sections. Members of the DG were assigned individual questions within these sections (refer to **Appendix 2** for **Clinical Questions**). The DG members met 25 times throughout the development of these guidelines. All literature retrieved were appraised by at least two DG members using Critical Appraisal Skill Programme checklist, presented in evidence tables and further discussed in each DG meetings. All statements and recommendations formulated after that were agreed upon by both the DG and RC. Where evidence was insufficient, the recommendations were made by consensus of the DG and RC. This CPG is based largely on the findings of systematic reviews, meta-analyses and clinical trials, with local practices taken into consideration.

The literature used in these guidelines were graded using the US/Canadian Preventive Services Task Force Level of Evidence (2001), while the grading of recommendation was done using the principles of GRADE (refer to the preceding page).

On completion, the draft of the CPG was reviewed by external reviewers. It was also posted on the MoH Malaysia official website for feedback from any interested parties. The draft was finally presented to the Technical Advisory Committee for CPG, and the HTA and CPG Council MoH Malaysia for review and approval. Details on the CPG development by MaHTAS can be obtained from Manual on Development and Implementation of Evidence-based Clinical Practice Guidelines published in 2015 (available at http://www.moh.gov.my/index.php/pages/view/117).

OBJECTIVES

To provide evidence-based guidelines to those involved in the early management of head injury in primary or secondary/tertiary care

CLINICAL QUESTIONS

Refer to **Appendix 2**

TARGET POPULATION

INCLUSION CRITERIA

Adult patients presenting with head injury (18 years old and above)

EXCLUSION CRITERIA

The guidelines do not cover detailed definitive management of head injury.

TARGET GROUP/USER

This document is intended to guide healthcare professionals and relevant stakeholders including:-

i. Doctors
ii. Pharmacists
iii. Allied health professionals
iv. Medical students and healthcare trainees
v. Professional societies
vi. Patients and carers/non-governmental organisations

HEALTHCARE SETTINGS

Primary or secondary/tertiary care settings

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The draft guidelines were reviewed by a panel of experts from both public and private sectors. They were asked to comment primarily on the comprehensiveness and accuracy of the interpretation of evidence supporting the recommendations in the guidelines.

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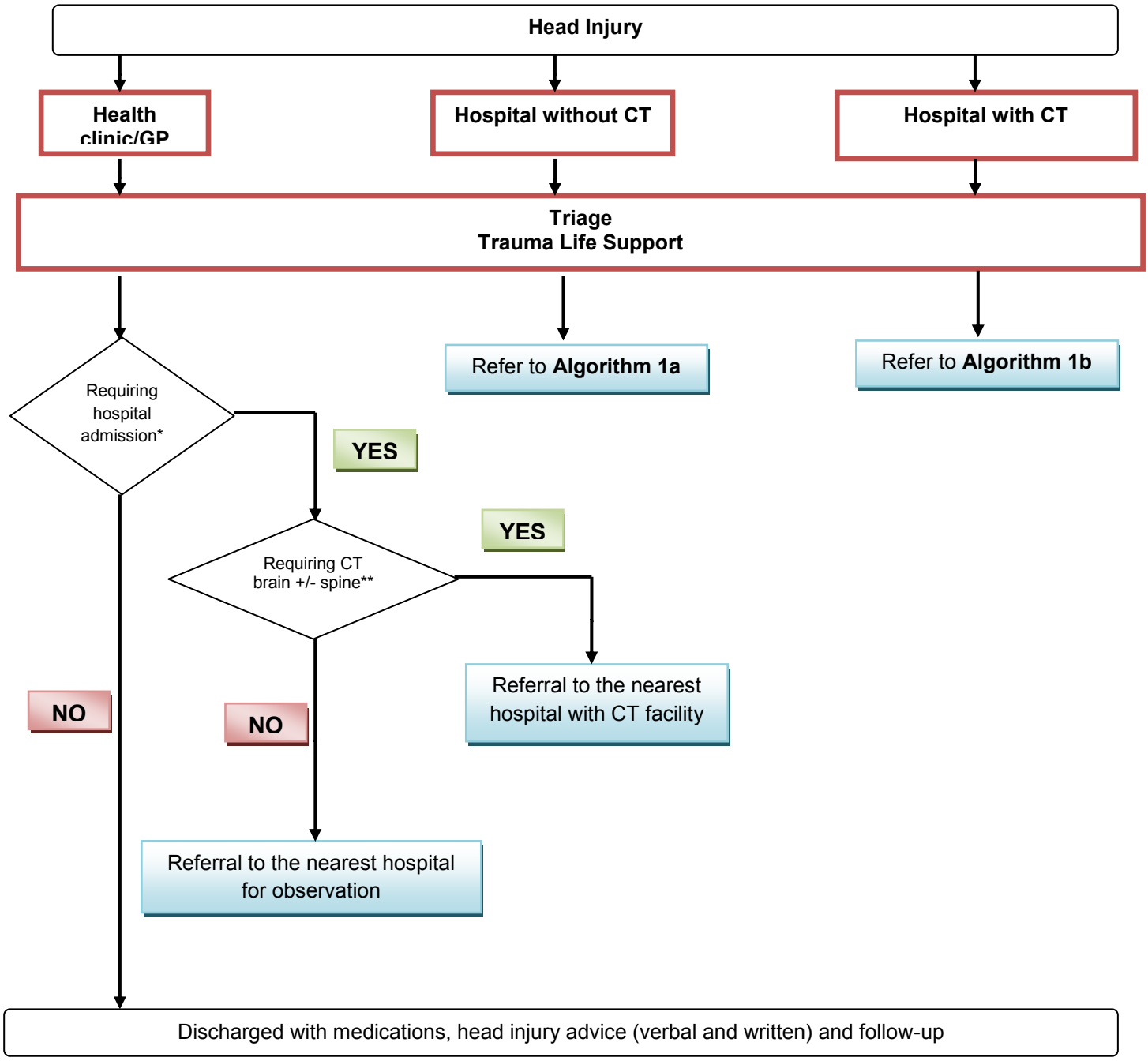
The following external reviewers provided feedback on the draft:-

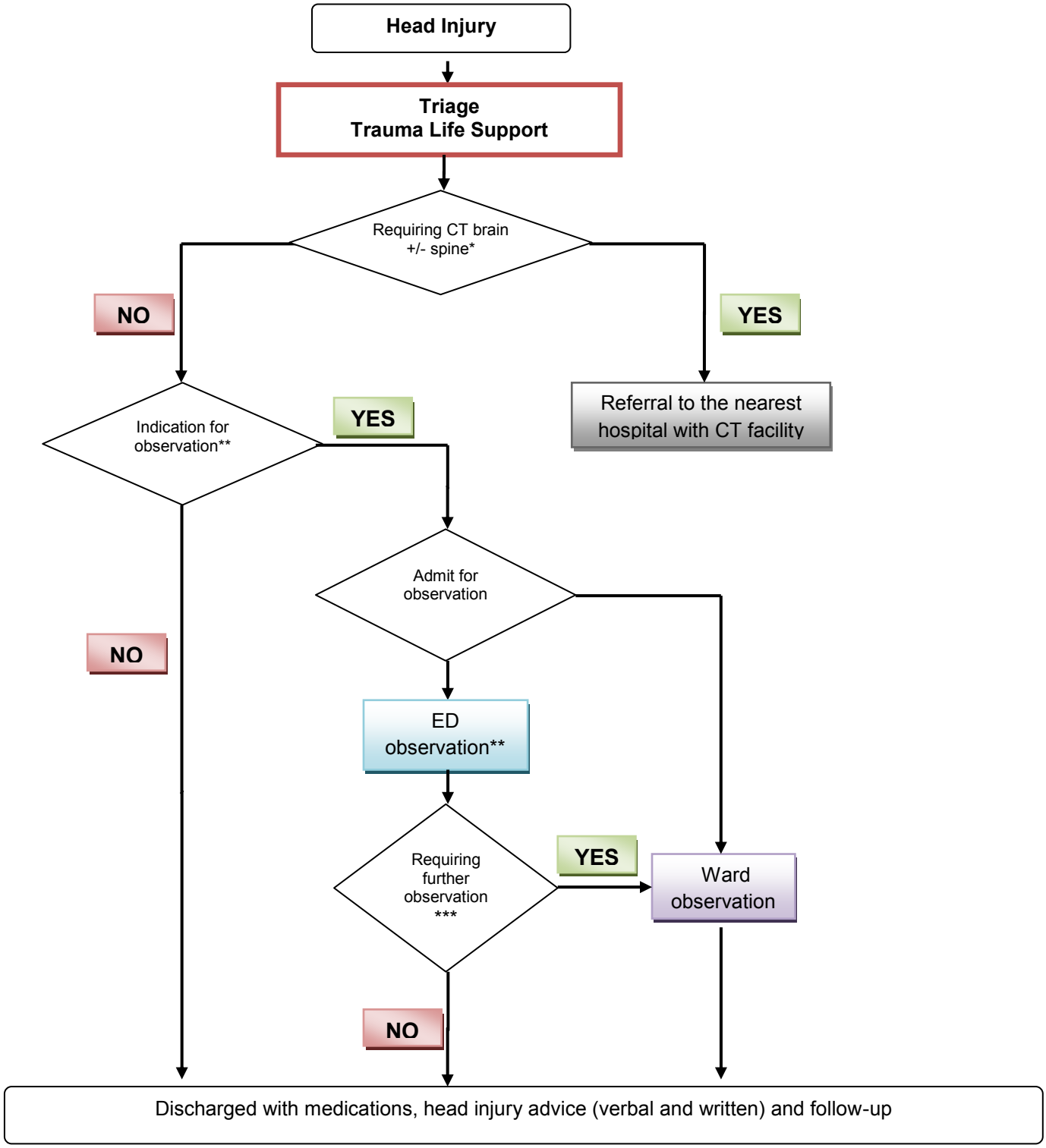
ALGORITHM 1. GENERAL MANAGEMENT OF ISOLATED HEAD INJURY



For those who are not sure which hospital to refer to please direct referral to nearest hospital

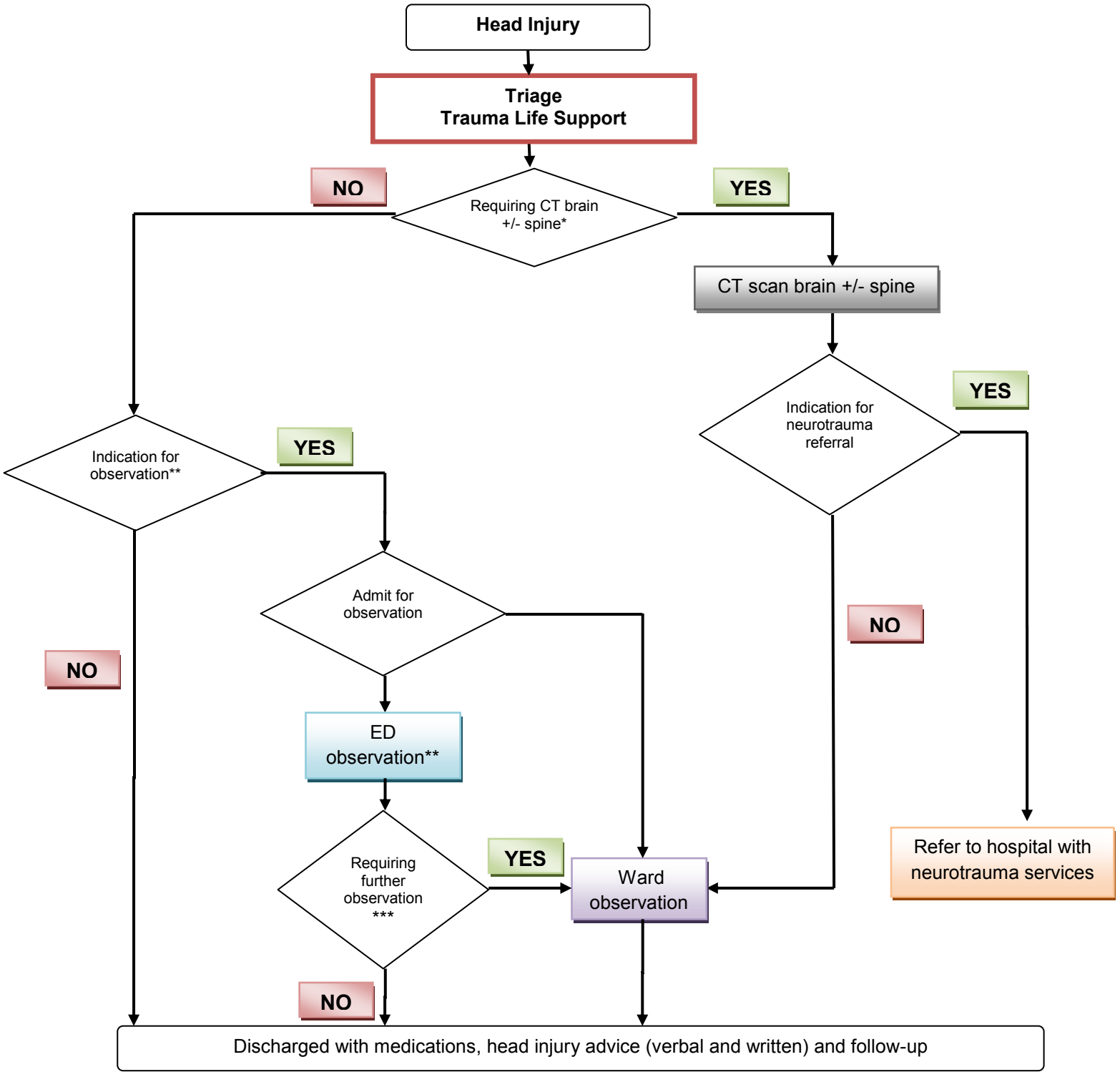
*Refer to **Recommendation 3** on **Criteria of Referral to Hospital on Patients with Mild Head Injury**
Refer to **Algorithm 3 on **Selection of Patient for Head CT**

ALGORITHM 1a. GENERAL MANAGEMENT OF ISOLATED HEAD INJURY IN HOSPITAL WITHOUT CT FACILITIES



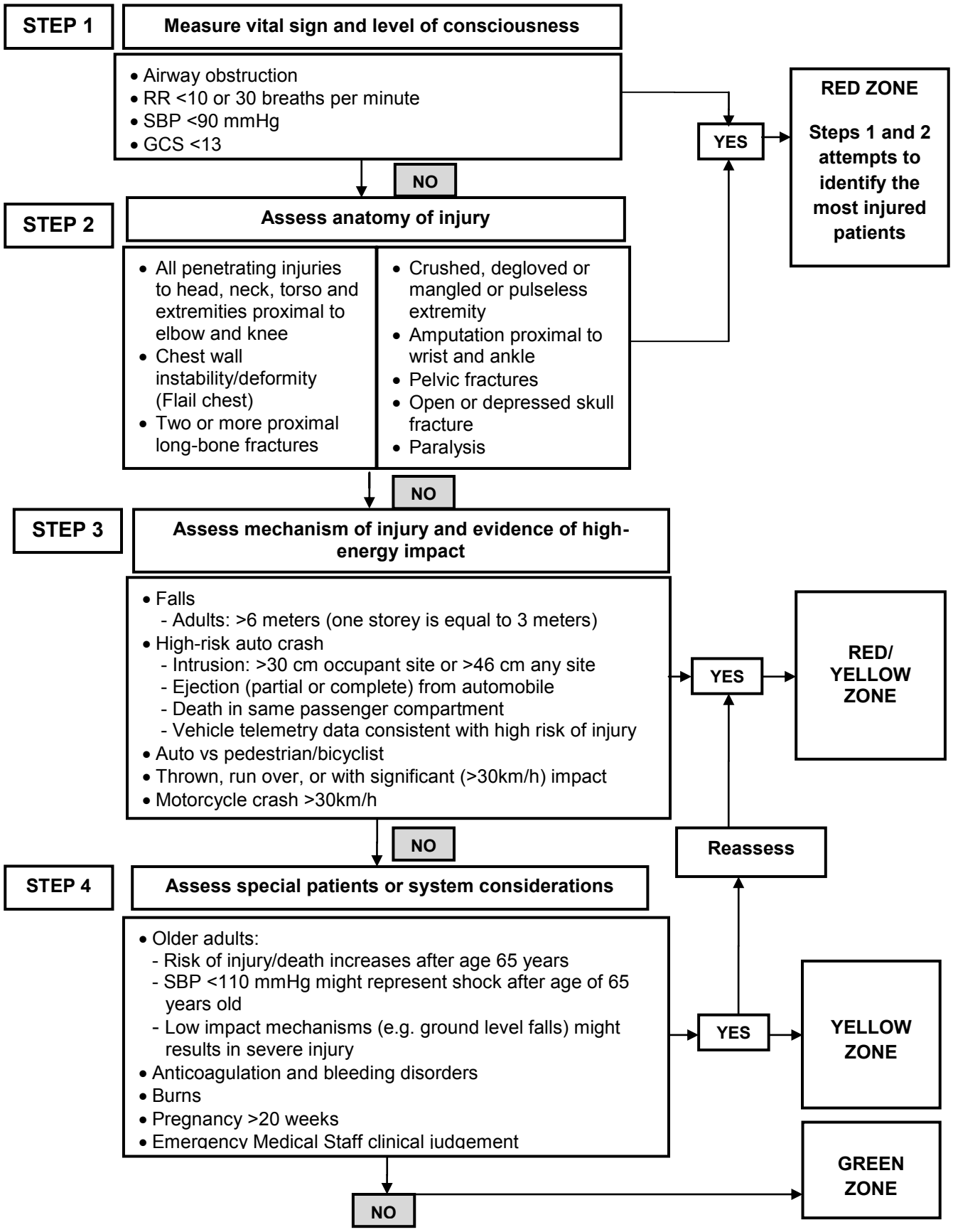
*Refer to **Algorithm 3** on **Selection of Patient for Head CT**
Refer to **Recommendation 7 on **Criteria of Patients with Mild Head Injury Who Can Be Observed Safely in ED**
***Refer to **Recommendation 10** on **Criteria of Patients with Mild Head Injury Admission Post-observation in ED**

ALGORITHM 1b. GENERAL MANAGEMENT OF ISOLATED HEAD INJURY WITH CT FACILITIES



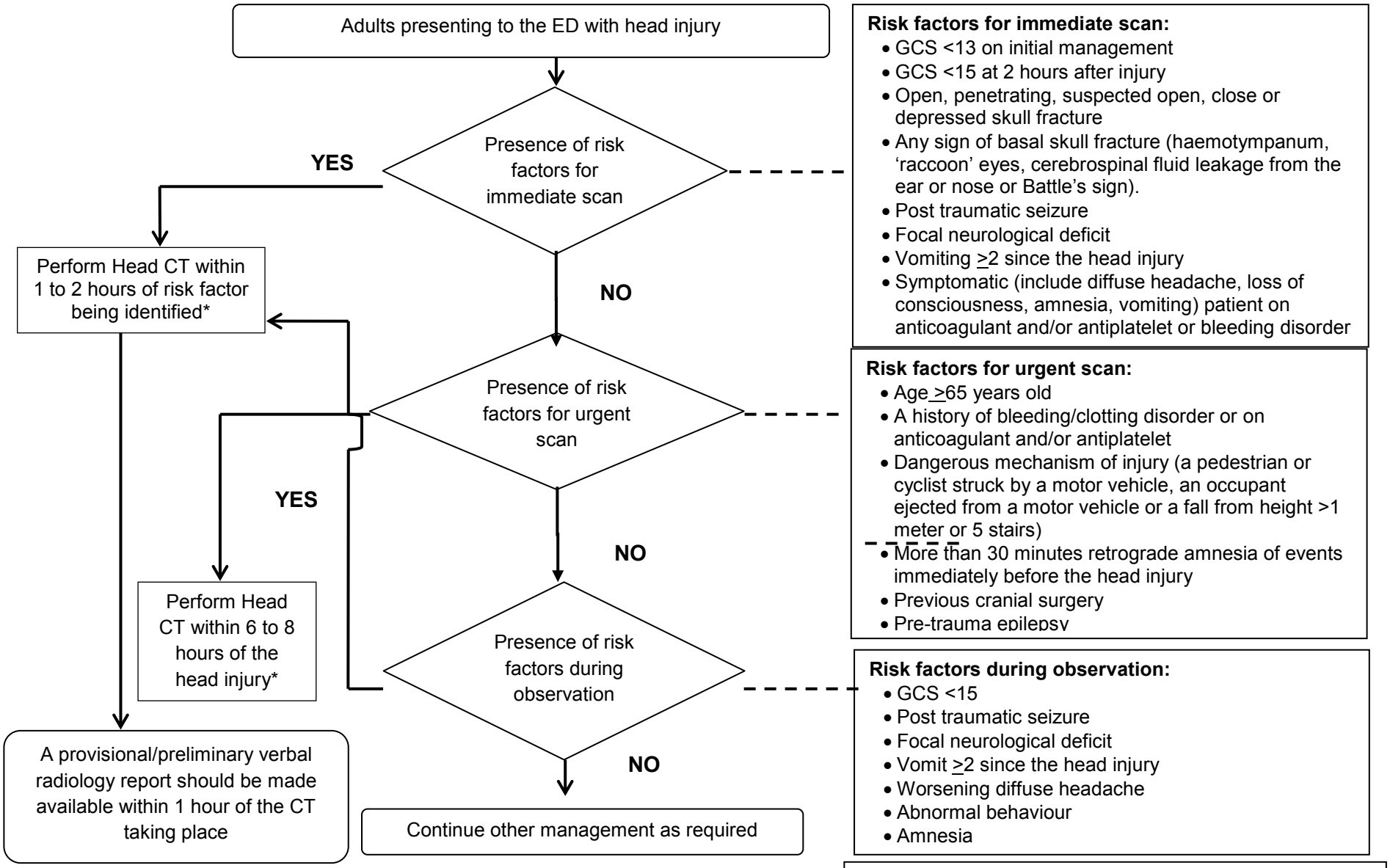
*Refer to **Algorithm 3** on **Selection of Patient for Head CT**
Refer to **Recommendation 7 on **Criteria of Patients with Mild Head Injury Who Can Be Observed Safely in ED**
***Refer to **Recommendation 10** on **Criteria of Patients with Mild Head Injury Admission Post-observation in ED**

ALGORITHM 2. TRIAGING OF PATIENTS WITH SUSPECTED HEAD INJURY IN PRE-HOSPITAL CARE OR EMERGENCY DEPARTMENT



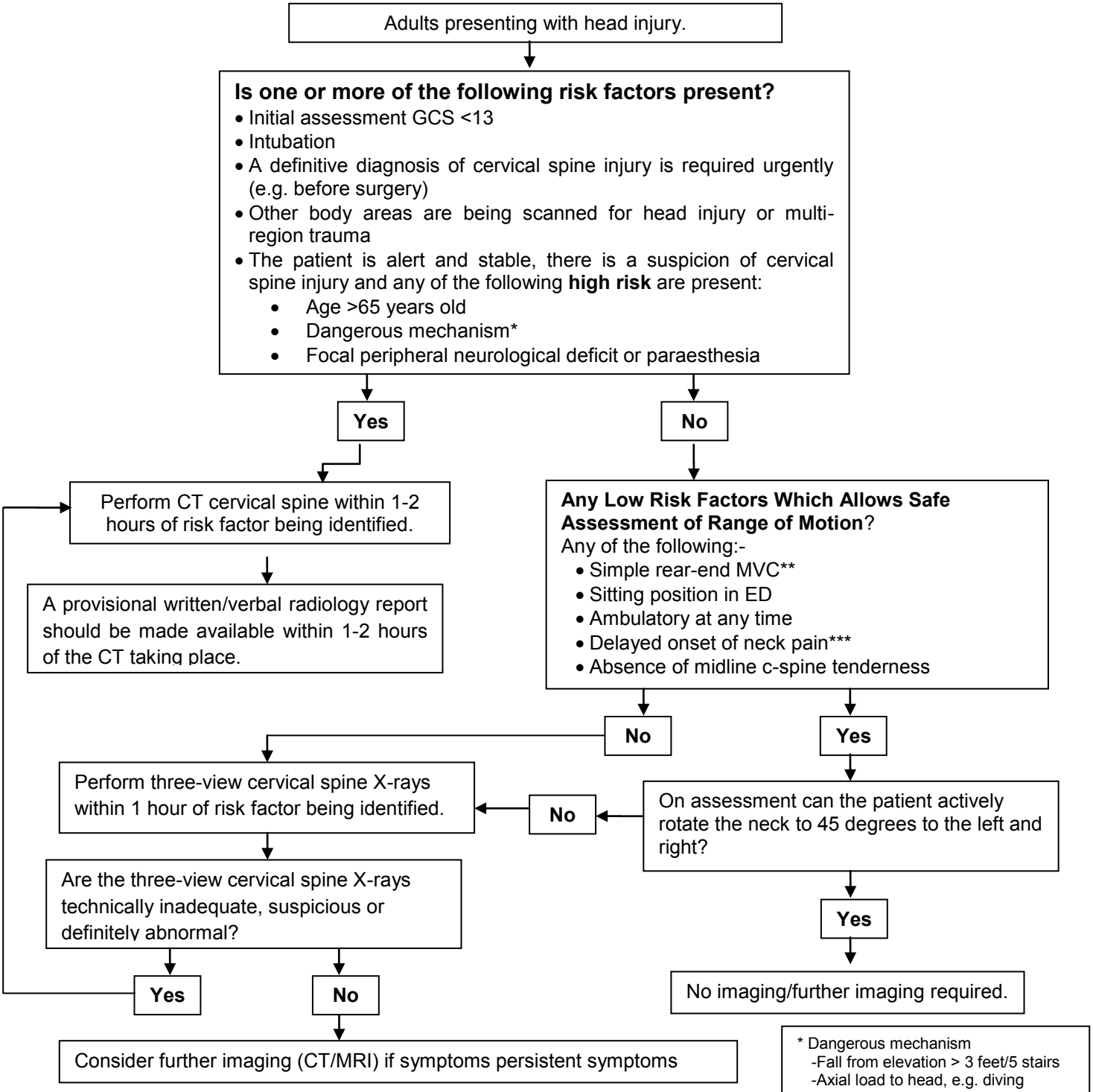
Adapted from: American College of Surgeon Committee on Trauma Advanced Trauma Life Support Student Course Manual (9th Edition). Chicago: 2012

ALGORITHM 3. SELECTION OF PATIENT FOR HEAD CT



Adapted from: National Institute for Health and Care Excellence. Triage, assessment, investigation and early management of head injury in children, young people and adults. UK: NICE; 2014

ALGORITHM 4. SELECTION OF ADULTS FOR IMAGING OF THE CERVICAL SPINE



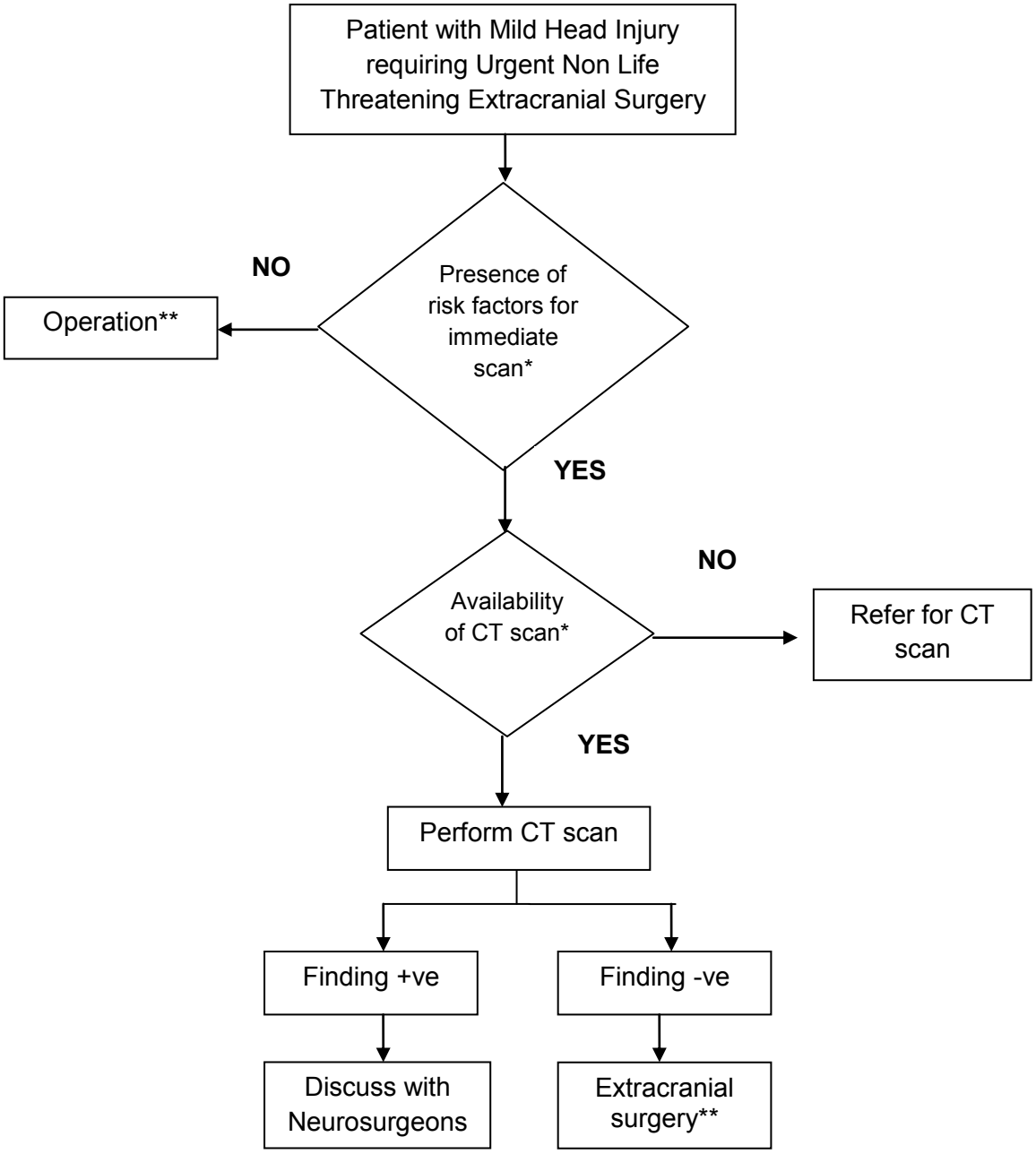
* Dangerous mechanism
-Fall from elevation > 3 feet/5 stairs
-Axial load to head, e.g. diving
-MVC high speed (> 100km/hour)
-Rollover,ejection
-Motorized recreational vehicles
-Bicycle collision

** Simple rear-end MVC excludes:
-Pushed into oncoming traffic
-Hit by bus/large truck
-Rollover
-Hit by high speed vehicle

*** Delayed
i.e. not immediate onset of neck pain

Adapted from: National Institute for Health and Care Excellence. Triage, assessment, investigation and early management of head injury in children, young people and adults. UK: NICE; 2014.

ALGORITHM 5: PATIENT WITH MILD HEAD INJURY REQUIRING URGENT NON-LIFE THREATENING EXTRACRANIAL SURGERY



* Refer to **Algorithm 3** on **Selection of Patient for Head CT**
**Anaesthesia administer adhering to principle of neuroanaesthesia

1. INTRODUCTION

Injury was the fifth (7.86%) commonest cause of hospitalisation in MOH hospital Malaysia in 2014.[Health Facts MOH, 2015] The younger age group between 15-34 years (56.6%) was at the highest risk of major trauma.[Jamaludin S.F, 2009] Road traffic accident was the commonest cause of injury-related hospitalisations.

Head injury was the commonest diagnosis leading to intensive care unit (ICU) admission in 2008 based on The National Audit on Adult Intensive Care Units (NAICU) report.[MOH, 2009] It showed high disease burden contributed by head injury.

In the Malaysian National Trauma Database 2009 Report, blunt trauma made up 96% of injury. Road trauma accounted for 75% of cases with motorcyclists being most commonly injured. High proportion 86% of major trauma patients had injuries to the head and neck with AIS >3.85% of all trauma patients with head injury have some form of intracranial injury.[Jamaludin S.F, 2009] Based on the World Health Organization Global status report on road safety 2013, the road traffic fatality rate was higher than global road traffic fatality rate (25 vs 18 per 100 000 population). Many lives can be saved with good pre-hospital care (PHC) and quick transportation to hospital.[WHO, 2013,

A local study on the effectiveness of trauma services provided by secondary and tertiary hospitals in Malaysia showed a reduction of mortality by 83% in severe injuries in those admitted to tertiary care hospital compared with those admitted to district general hospital. Nevertheless, those hospitalised in tertiary hospitals have a higher likelihood of disability and impairment upon discharge. It was concluded that there is a need to improve access to trauma services for severely injured patients in Malaysia. Apart from that, there are many variations in management of trauma care and its related facilities within hospitals in Malaysia. The differences include level of trauma care, standard operating procedure or policies related to on-site resuscitation, availability of on-site senior specialist care on a 24 - hour basis or specialists in emergency medicine, specialist trauma services, referral and transportation.[Sethi D et al., 2007, level III]

Strengthening of emergency services and PHC were identified as crucial in improving secondary care as stated in the country health plan strategy 2011 - 2015 report. Subspecialties development will continue to be strengthened in regional hospitals include expansion and strengthening of tertiary care related to trauma.[MOH, 2011-2015]

According to report of specialty and subspecialty framework of MOH hospitals 10th Malaysia Plan (2010 - 2015), only Hospital Kuala Lumpur and 13 states hospitals will be provided with neurosurgery subspecialty to manage complicated head injury. The remaining 130 MOH hospitals and institutions in Malaysia are not equipped with neurosurgery subspecialty.[MOH, 2011] However currently, there are only nine states and one district hospital with additional another three university hospitals providing neurosurgical subspecialties. In view of shortage in neurosurgeons in the country, the CPG helps to guide health care providers in the early management of patients with head injury and referral to the neurosurgical centres.

This is the first evidence-based local CPG that aim to guide healthcare providers in the early management of head injury. It intends to reduce clinical practice variation, provide optimum care of head injury patients and eventually achieve significant reduction in mortality and morbidity related to the condition. It also helps in optimising limited neurosurgery subspecialty services in the country with a systematic referral and, utilisation of tele-health services and consultation.

2. DEFINITION

Head injury is defined as blunt and/or penetrating injury to the head (above the neck) and/or brain due to external force* with temporary or permanent impairment in brain function which may or may not result in underlying structural changes in the brain.

One or more of the following conditions from both anatomical and physiological changes must be present in patients with head injury:

1. Anatomical changes
   - scalp and/or facial wound or swelling
   - skull fracture (facial, basilar or vault) and/or clinical signs of skull fracture
   - diagnosed intracranial lesion such as brain parenchyma injury, injury to intracranial blood vessels, injury to the dura mater, intracranial haemorrhage (ICH), subarachnoid haemorrhage or intraventricular haemorrhage

2. Physiological changes
   - observed or self-reported any period of loss of or a decreased level of consciousness
   - any loss of memory (amnesia) of events immediately before or after the injury
   - any alteration in mental state or neuropsychological abnormality at the time of the injury (such as loss of consciousness (LOC), confusion, disorientation and slowed thinking)
   - objective neurological deficits (such as weakness, loss of balance, change in vision, praxis, paresis/paraplegia, sensory loss and aphasia) that may or may not be transient

- To define head injury, three criteria must be present:
  i. mechanism - presence of external force*
  ii. anatomical - scalp and/or face and/or skull with or without brain injury (internal and external)
  iii. physiological - alteration in physiology of the brain such as LOC or amnesia

*The external forces may include any of the following events: the head being struck by an object, the head striking an object, the brain undergoing an acceleration/deceleration movement without direct external trauma to the head, a foreign body penetrating the brain, forces generated from events such as blast or explosion, or other forces yet to be defined.

3. CLASSIFICATION OF SEVERITY

The severity of head injury can be classified according the presenting Glasgow Coma Score (GCS):[Jennett B et al, 1977, level III]

- mild head injury (MHI): GCS 13 - 15
- moderate head injury: GCS 9 - 12
- severe head injury: GCS 3 - 8

The MHI group can be subdivided into two types as shown in **Table 1**.[Carney N et al., 2014, level III ; Fabbri A et al., 2004, level III; Peggy J. Parks. Concussions (Compact research series), 2014, level III]

Table 1. Classification of MHI

<table>
<tr><th colspan="3">Cerebral concussion</th><th colspan="3">Mild Head Injury</th></tr>
<tr><th colspan="3">GCS 15</th><th colspan="3">GCS 13-15</th></tr>
<tr><td colspan="3">Should only be used if there is no imaging evidence of brain injury</td><td colspan="3">With or without imaging evidence of brain injury</td></tr>
<tr><td colspan="3">With or without history of LOC</td><td colspan="3">Requires a LOC (≤30 minutes) or post traumatic amnesia (≤24 hours)</td></tr>
<tr><td colspan="3">Can be further subdivided into:</td><td colspan="3">Can be further subdivided according to the risk of deterioration and expected outcome:</td></tr>
<tr><td rowspan="2">Grade 1</td><td rowspan="2">Grade 2</td><td rowspan="2">Grade 3</td><td>Low Risk</td><td>Medium Risk</td><td>High Risk</td></tr>
<tr><td>GCS 15</td><td>GCS 14-15</td><td>GCS 13</td></tr>
<tr><td>• History of confusion
• No history of LOC
• Concussion symptoms resolve in <15 minutes</td><td>• History of confusion
• No history of LOC
• Concussion symptoms last >15 minutes</td><td>• History of LOC either brief (seconds) or prolonged (minutes)</td><td>With one or more of the clinical findings</td><td colspan="2">With neurodeficits or skull fracture or risk factors with/without clinical findings</td></tr>
<tr><td colspan="3">Concussion symptoms are divided into four categories:
1. Physical
headache, fuzzy or blurry vision, sensitivity to noise and/or light, dizziness, feeling tired and lacking energy, and problems with balance
2. Cognition/memory
difficulty thinking clearly, feeling slowed down, trouble concentrating, and difficulty remembering new information
3. Emotional/mood
irritability, inexplicable sadness, nervousness and/or anxiety
4. Sleep disturbances
interruptions in normal sleep patterns</td><td colspan="3">Clinical findings:
LOC, amnesia, diffuse headache, vomiting

Risk factors:
Coagulopathy, alcohol consumption and/or drug misuse, age >60 years old, previous cranial surgery and history of pre-trauma epilepsy</td></tr>
</table>

4. DIFFERENTIAL DIAGNOSES

The differential diagnoses of adult head injury include the following:

- primary anoxic, inflammatory, infectious, toxic or metabolic encephalopathies, which are not complications of head trauma
- neoplasm
- brain infarction (ischaemic stroke) and intracranial haemorrhage (haemorrhagic stroke) without associated trauma
- alcohol intoxication, psychotropic drugs or substance abuse
- seizure

5. PRE-HOSPITAL CARE/MANAGEMENT

PHC is defined as an immediate assistance a patient receives from PHC providers before arriving at hospital. Mortality and morbidity due to traumatic brain injury (TBI) may be reduced by adequate pre-hospital trauma care.

The first responder who recognises the emergency situation is encouraged to rapidly activate emergency response system by dialling 999 and provide basic first aid measures. Most deaths in the first hour after injury are the result of airway and circulatory systems compromise. Appropriate assessment, stabilisation and care of trauma victim including referral and transportation to appropriate receiving facility will help avoid secondary brain injury.

5.1 Assessment and General Treatment

The Glasgow Coma Scale and Score are widely used in patients with TBI due to their good reliability and validity. They measure patient's best eye, motor and verbal responses, and categorised it into mild (GCS 13 to 15), moderate (GCS 9 to12) and severe (GCS 3 to 8).[SIGN, 2009] They are reliable tools to monitor and detect deterioration in patients with TBI. Alcohol intoxication, sedative medications, hypoxia and hypotension can confound conscious level. Therefore any assessment of GCS should be repeated after resuscitation from cardiopulmonary insult or recovery from intoxication and sedation in patients with head injury. Other assessments that can be used are Head (AIS) and Trauma Score - Injury Severity Score.

- Training on the use of GCS is essential for accurate assessment of patients with head injury.

Total GCS and GCS Motor Scores including those at pre-hospital are stronger predictors of 2-week mortality than Head AIS Score scales after TBI. Aged 60 or older is an independent risk factor for the mortality.[Timmons SD et al., 2011, level II-2]

Alcohol intoxication (blood alcohol concentration >0.08%) is an important confounder for the pre-hospital assessment of GCS examination in alcohol intoxicated patients with TBI ($p<0.001$).[Shahin H et al., 2007, level II-2]

Recommendation 1

- Glasgow Coma Scale (GCS) and Glasgow Coma Scale Score (GCS score) should be used in the assessment of all patients with head injury by trained healthcare providers.

5.2 Initial Management

5.2.1 Airway

The most important pre-hospital management in TBI is the maintenance of airway, breathing and circulation. Hypoxaemia (oxygen saturation [SpO_2] <90%) is the most important factor related to worse outcome (more mortality and severe disability with SPO_2 less than 90%) and therefore needs urgent attention.[Badjatia N et al., 2007, level III]

A systematic review of studies on pre-hospital intubation in severe head injury concludes:

- The adjusted ORs for in -hospital mortality ranged from 0.24 (95% CI 0.11 to 0.49) to 1.42 (95% CI 1.13 to 1.78),
- There were inconclusive results on functional outcome.
- Intubation failure or complication rates (e.g. pneumonia) ranged from 2.1% to 41.1%.

Although there was insufficient evidence to suggest any recommendation, benefit and harm of pre-hospital intubation in severe TBI depend on organisation of PHC services, skills of staff, risk of procedure failure and expected transport times.[E.von Elm et al., 2009, level II-2]

An airway should be established by the most appropriate means available in severe TBI (GCS <9) to maintain an adequate airway or when hypoxaemia not corrected by supplemental oxygen.[Badjatia N et al., 2008, level III]

Manual in line stabilisation must be performed in suspected cervical spine injury and rapid sequence intubation is the preferred choice of intubation technique as it is proven to be not associated with increased risk of adverse neurological outcomes.[Ahn H et al., 2011, level I]

Manual in-line stabilisation is provided by assistant during intubation by using the fingers and palms of both hands to stabilise the patient's occiput and mastoid processes to gently counteract the forces of airway intervention. Prior to this maneuver, the anterior half of a semi rigid collar is removed. The assistant stands at the head or side of the bed. Manual in-line stabilisation anchors the occiput and the torso anchors the lower cervical spine.[Austin N et al., 2014, level III] Caution should be taken during the procedure as laryngoscopic forces can still be translated to the mid-cervical spine

5.2.2 Cervical Spine

Unstable spinal injury may occur concomitantly with TBI and lead to permanent neurological deficit if not addressed appropriately.[AAGBI, 2006, level III] Hence, risk of cervical injury must be ruled out. Full cervical spine immobilisation should be attempted in TBI patients with any of the following risk factors:[NICE, 2014]

- GCS <15 on initial assessment by the healthcare professional
- paraesthesia in the extremities
- neck pain or tenderness
- focal neurological deficit
- any other clinical suspicion of cervical spine injury

5.2.3 Circulation

Hypotension is defined as a SBP <90 mmHg in adults.[Brain Trauma Foundation; AANS/CNS, 2008, level III] Untreated hypotension will produce secondary brain insult and studies have demonstrated that a single episode of hypotension significantly worsens the outcome.[Chowdhury T et al., 2014, level III] Options of treatment include fluid resuscitation. The mean arterial pressure (MAP) should be maintained at 80 mmHg or more by infusion of fluid and or vasopressors as indicated.[NICE, 2014]

There is no benefit on survival or functional outcome, and also no difference in hospital length of stay upon usage of hyperosmolar crystalloid or colloid solutions over isotonic crystalloids in pre-hospital fluid resuscitation of patients with TBI. Hypotension and hypoxia however must be avoided, and fluid resuscitation should be sufficient to maintain cerebral perfusion.[Tan PG et al., 2011, level I]

A multicentre Saline Albumin Fluid Resuscitation Trial showed that the use of albumin was associated with higher mortality in patients with severe head injury. Among patients with severe brain injury (GCS 3 - 8), 41.8% of them died in the albumin group as compared with 22.2% patients in the saline group. However in those with GCS scores of 9 - 12, death occurred in eight of 50 patients in the albumin group (16.0%) and eight of 37 patients in the saline group (21.6%).[Myburgh J et al., 2007, level I]

Recommendation 2

- Hypoxaemia (oxygen saturation [SpO_2] <90%) should be avoided in head injury and corrected immediately upon identification. Oxygen supplementation should be given to all patients with head injury to prevent hypoxaemia.
- An airway should be established in head injury patients, by the most appropriate means* available in the following conditions:
  - severe head injury (Glasgow Coma Scale ≤8)
  - inability to maintain an adequate airway
  - hypoxaemia not corrected by supplemental oxygen

  Manual in-line immobilisation should be performed during intubation.
- Cervical collar should be applied in head injury patients with suspected cervical injury**.
- Isotonic crystalloid is the preferred choice of intravenous fluid resuscitation in head injury.

*Using either definitive (e.g. endotracheal intubation) or non-definitive airway (e.g. laryngeal mask airway) depending on expertise and resources
**Refer to the related preceding text

5.3 Referral or Discharge at Primary Care Setting

The need to make a decision to refer or discharge a patient with head injury who is seen in a primary health setting can be very challenging. This is especially so in presumably mild cases as there is a possibility that the cases may have pre-existing risk factors to intracranial bleeding or symptoms masked by intoxication.

A number of patients presenting with MHI with the following findings may eventually require neurosurgical intervention:[Clement CM et al., 2006, level III]

- restlessness
- decrease in GCS score within six hours
- severe headache
- focal temporal blow
- vomiting
- confusion

Male gender [OR=3.82 (95% CI 1.60 to 9.13)] and alcohol intoxication [OR=12.44 (95% CI 2.14 to 72.38)] are important risk factors of delayed referral.[Raj R et al., 2013, level III]

There is a possibility of ICH after minor head trauma in patients taking anticoagulant and/or antiplatelet medication. The frequency of a positive computed tomography (CT) with regards to anticoagulation is 27%, antiplatelet 41% and combined therapy 14%.[Brewer ES et al., 2011, level III]

Platelet count in TBI patients on antiplatelet therapy contributed to negative outcome. Patients on clopidogrel therapy and high-dose aspirin therapy (p=0.001) are more likely to have progression of ICH and require neurosurgical intervention (p=0.01) compared with patients on low-dose aspirin therapy. Platelet count of ≤135,000/HL is the strongest predictor for progression of initial ICH (p<0.001) on repeat head computed tomography (RHCT). A lower platelet count i.e. ≤95,000/μL is the strongest predictor (p<0.001) for neurosurgical intervention.[Joseph B et al., 2014, level III]

In older patients (≥55 years old) with TBI, those on anticoagulation therapy are 4.6 times (95% CI, 1.08 to 19.6) more likely to have a secondary intracranial haemorrhage event (SIHE) compared with antiplatelet users and non-users on follow-up. The anticoagulant users are also more likely to have progression of initial haemorrhage.[Peck KA et al., 2014, level II-2]

A multivariate logistic regression model for patients who present with isolated moderate to severe TBI with regard to age, male gender, injury severity score (ISS) ≥16, GCS score ≤8, systolic blood pressure (SBP), and diabetes mellitus (DM) were found to be significant. DM is an independent predictor for mortality in moderate to severe TBI with OR=1.5 (95%, CI 1.29 to 1.74; p<0.0001).[Ley EJ et al., 2011, level III]

In a cohort study of isolated TBI patients, pre-hospital hypertension of >160 mmHg is an predictor for in-hospital mortality:[Barmparas G et al., 2014, level III]

- OR for pre-hospital SBP of 160 - 180 mmHg was 1.33 (95% CI 1.22 to 1.44)
- OR for pre-hospital SBP of 190 - 230 mmHg was 1.97 (95% CI 1.76 to 2.21)

A deviation from admission heart rate (HR) of 70 beats per minute (bpm) to 89 bpm was associated with increased mortality (p<0.001).

Another cohort study factors showed that factors associated with mortality in TBI patients were:[Tohme S et al., 2014, level II-2]

- GCS <9 (HR=2.08, 95% CI 1.25 to 3.46)
- abnormal pupil (HR=2.08, 95% CI 1.25 to 3.46)
- ISS ≥25 (HR=2.62, 95% CI 1.48 to 4.63)
- SBP <90 mmHg (HR=2.13, 95% CI 1.12 to 4.04)
- hypothermia <35^{0}C (HR=1.42, 95% CI 1.00 to 2.01)

Recommendation 3

- Referral of patients with mild head injury to the nearest hospital should be considered if they have the following factors:
  - Glasgow Coma Scale (GCS) of 15 but symptomatic such as amnesia, headache, vomiting or restlessness
  - age >65 years old
  - patients treated with antiplatelets or anticoagulants
  - declining GCS score
  - alcohol intoxication and substance misuse
  - focal temporal blow
  - social issues such as transport, communication problem or no supervision by a responsible adult
  - other criteria that fulfil indication for CT scan as mention in **Algorithm 3** on **Selection of Patient for Head CT**

5.4 Transportation

Neuro-trauma services in Malaysia are available in hospitals with general and neurosurgeons. Many patients with head injuries are transferred to these hospitals by road or occasionally by air or river/sea. During transportation, patients with impaired consciousness and physiological instability may develop secondary insults and predispose to worse outcome. Best practice directed by evidence-based protocols or management prior and during transport can minimise these adverse events.[SIGN, 2009]

The main objective of patient transfers is to ensure patients are safe to reach the destination in the most appropriate time. The criteria for the mode and rapidity of transferring patients with head injury in the pre-hospital setting are based on the risk of intracranial complications and severity of head injury.

5.4.1 Transferring Head Injury Patients from the Scene of Injury to Hospital

Patients with suspected TBI preferably should be transported from the scene directly to a centre where TBI can be managed in its entirety (centre with resources necessary to resuscitate, investigate and initially manage any patients with polytrauma). Alternatively patients can be directly transported to a centre capable to initially manage their condition. Standby calls should be made earlier to inform the ED especially in cases of GCS ≤8. Cervical spine immobilisation should be maintained during transfer until a full assessment and appropriate investigations are performed. The mode of transport selected should minimise total pre-hospital time. On scene management of TBI patient and transfer must follow the current standard management. Unnecessary delay in transfer must be avoided.[Ayson M., 2011, level III]

Transferring polytrauma patients with suspected TBI to an appropriate facility with established trauma system is associated with a 15% reduction in overall mortality.[Ayson M., 2011, level III]

5.4.2 Transferring Head Injury Patients from Clinic to Hospital

- Criteria for rapid transfer to hospital using PHC services:[Ayson M., 2011, level III]
  - deterioration in patient's condition
  - GCS <15
  - focal neurological deficit
  - seizure
  - suspected skull fracture or penetrating head injury
  - high impact head injury
  - suspected neck injury

Patients referred from primary care should be accompanied by competent adults. The referring health care providers should determine whether an ambulance or other mode of medical transport is required. Public transport and car are appropriate alternative means provided the patients are accompanied. The referring health care providers should also contact the referral hospital by phone of the impending transfer.[NICE, 2014] The decision to transfer patients from a rural location should be discussed between the referring and receiving healthcare providers.[SIGN, 2009] Criteria for the rapidity and mode of transport from the pre-hospital setting to ED are based on the risk of clinically important TBI and the acute intracranial complications of TBI.

5.4.3 Transferring Head Injury Patient from ED/Hospital without Neurotrauma Service to Neurotrauma Centre

Patients with persistent hypotension despite resuscitation should have the cause of hypotension identified and managed in hospital with surgical services. Advanced airway management including intubation may be required prior to transfer and must be done by trained healthcare providers.[Ryynänen OP et al., 2010, level I] The risk of secondary brain injury during transfer to tertiary centre is high if poorly executed. Transfer purely for the purpose of imaging in unstable patients should be avoided.[SIGN, 2009]

- Initial management including resuscitation and stabilisation are essentials, and should be completed before transferring TBI patients:[NICE, 2014; Brain Trauma Foundation; AANS/CNS, 2008, level III; AAGBI, 2006, level III]
  - Intubate and ventilate patients with TBI if:
    - GCS $\leq$8 or significant drop of total GCS score $\geq$2 or motor component $\geq$1
    - unstable fractures of the facial skeleton
    - copious bleeding into mouth (e.g. from skull base fracture)

- hypoxaemia
- seizure
- respiratory irregularities
- hyperventilation causing hypocarbia

  - Cause of persistent hypotension should be identified and managed in hospital with surgical services
  - If patient has seizure, treat with anticonvulsant (refer to **Chapter 8.4** on **Anticonvulsant**)

During transfer, hypotension, hypercarbia and hypoxia are the main causes of secondary brain damage in patients with TBI. Hence, it is important to maintain adequate oxygenation and ventilation with appropriate short-acting sedation and analgesia and to avoid SpO2 <90%.[AAGBI, 2006, level III]

The general principles of safe transfer are:

- ensure haemodynamic stabilisation (Refer to **Section 5.2** on **Pre-hospital Management** and **Section 9.2** on **Intravenous Fluid**)
- secure of bleeding prior to transfer e.g. applying haemostatic suturing for bleeding scalp wound and applying splint for long bone fractures.[AAGBI, 2006, level III]
- intubation if required (Refer to **Section 5.2** on **Pre-hospital Management**)
- total spinal immobilisation (e.g. combination of cervical collar, head immobiliser, spinal board or stretcher*) if spinal injury has not been ruled out
- the transfer team should be trained in neuro-trauma management
- reliable communication equipment is essential to allow effective communication between the transfer team with their hospital and the neurosurgical team
- completed transfer checklist for neurosurgical patients (Refer to **Appendix 9** on **Transfer Checklist for Neurosurgical Patients)**

*Stretcher is preferable to traditional spinal board. Hence, patient should be taken off the spinal board while awaiting transfer. There is insufficient evidence of safe duration for patient immobilisation on spinal board.[Ahn H et al., 2011, level I]

- The fundamental requirements prior to transfer include adequate oxygenation delivery and optimised vital parameters:[Ayson M., 2011, level III]
  - target MAP >80 mmHg, PaO_2 >97.5 mmHg (13 kPa), $PaCO_2$ between 34 mmHg - 37.5 mmHg (4.5 - 5.0 kPa), SpO_2 > 90%
- Transfer monitoring to include:
  - pupil size and reaction to light, cardiac monitoring, BP, pulse oximetry, capnography (if available) and urine output
- Investigations before transfer when necessary are*:
  - full blood count, coagulation screen, blood sugar, blood group cross-match, arterial blood gases, radiological investigations [CT scan (where available), chest x-ray, pelvic/other and other investigations as appropriate]

*The investigations should not delay transfer

A copy of the summary and transfer record should be kept for audit purposes.[AAGBI, 2006, level III]

Recommendation 4

- Hypotension, hypoxia, hypocarbia and hypercarbia, and inadvertent cervical injury should be avoided before and during process of transfer.
- Continuous monitoring of vital signs should be conducted during transfer of head injured patients*.
- Effective communication should be established between the transfer team and receiving hospital.

*Refer to **Appendix 9** on **Transfer Checklist for Neurosurgical Patients**

6. EMERGENCY DEPARTMENT (ED)

6.1 Triage

The purpose of triage is to ensure the right patient receives appropriate timely treatment in the right place before she or he deteriotes. A systematic method ensures quick work flow process. Triage of patients with head injury in many countries has been based on American College of Surgeon-Committee on Trauma/Centre for Disease Control (ACOS-COT/CDC) 2011 Physiologic and Anatomical Guidelines for field triaging of injured patients.[Pearson WS et al., 2012, level III]

Based on this guideline, there is increased likelihood of death in TBI with the following physiological factors:[Pearson WS et al., 2012, level III]

- GCS ≤13 (OR=17.4, 95% CI 10.7 to 28.3)
- Respiratory rate (RR) <10 breaths per minute and >29 breaths per minute in adults (OR=20.3, 95% CI 13.4 to 30.8)
- SBP <90 mmHg (OR=18.6, 95% CI 14.0 to 24.7)

Combination of all three physiologic criteria markedly increases the OR to 67.8 (95% CI 48.3 to 95.3).

In trauma patient, with the following anatomical criteria outlined in the same guidelines, there is increased likelihood of death:[Lerner EB et al., 2013, level III]

- flail chest (LR=42.4, 95% CI 6.3 to 284.0)
- open or depressed skull fracture (LR=18.9, 95% CI 11.6 to 30.8)
- pelvic fracture (LR=12.3, 95% CI 9.1 to 16.5)
- penetrating injury to the head, neck, torso and extremities (LR=49.7, 95% CI 42.3 to 58.3)
- two or more proximal long-bone fractures (LR=7.1, 95% CI 5.0 to 10.1)

An earlier study showed that the predictors of mortality in patients with blunt TBI were:[Hsiao KY et. al., 2008, level II-2]

- age (OR=1.04. 95% CI 1.01 to 1.07)
- GCS <9 (OR=19.29, 95% CI 5.04 to 73.82)
- skull bone fracture (OR=10.44, 95% CI 3.59 to 30.38)

A four-step algorithm based on physiologic abnormalities, anatomic injuries, mechanism of injuries, and co-morbidities and age (modified from ACOS-COT/CDC triaging guidelines) shows that the following factors are associated with a higher risk of undertriage:[Nakahara S et al., 2010, level III]

- isolated head injury with GCS 13-15 (talk and deteriorate) (OR=14.0, 95% CI 4.55 to 43.3)
- age of 45-54 years old (OR=10.8, 95% CI 1.88 to 61.7)
- isolated pelvic injury (OR=14.2, 95% CI 2.58 to 78.0)
- night time arrival (OR=2.45, 95% CI 1.04 to 5.79)

Triage of patients suspected of head injury is suggested to follow an **Algorithm 2** on **Triaging of Patients with Suspected Head Injury in PHC or ED** adapted from ACOS-COT/CDC triaging guidelines.

Recommendation 5

- Triage of patients suspected of head injury in pre-hospital care or on arrival in emergency department should follow a four-step algorithm* based on physiologic abnormalities, anatomic injuries, mechanism of injuries and co-morbidities and age.

*Refer to **Algorithm 2** on **Triaging of Patients with Suspected Head Injury PHC or ED**

6.2 General Treatment

Initial management of patients with head injury should be performed according to primary survey of trauma patients as recommended by Advanced Trauma Life Support guidelines:[ATLS, 2012]

- airway patency and cervical spine protection
- breathing
- circulation and haemorrhage control
- disability
- exposure

- Stabilisation of airway, breathing and circulation is the priority for all ED patients before attending to other injuries.
- In patients with depressed conscious level, head injury need to be ruled out before diagnosis of intoxication is made.
- All health care providers in ED should be trained in the assessment of patients with head injury and identification of risk factors for CT head and cervical spine imaging.

In patients with head injury where GCS ≤8, intubation is recommended for airway protection. To prevent secondary injuries, parameters such as PO_2, PCO_2, BP, PR, SpO_2 and glucose level should be assessed and be within normal range.[ATLS , 2012]

In a study based on National Trauma Data Bank which included mild and moderate head injury, base deficit and mortality analysis showed that the first presenting SBP <110 mmHg in hospital was a more clinically relevant definition of hypotension and hypoperfusion less than 90 mmHg, independent of both age and gender of the patients. There was an increase of approximately 6% in mortality for every 10 mmHg decrease below SBP 115 mmHg, with a maximum of 40% mortality at SBP 60 mmHg. However, further studies are warranted to support these findings.[Eastridge BJ et al., 2007, level III]

In traumatic ICH, a clinical decision rule consisting of a full GCS, isolated head injury and age <65 years) where the patients who do not require critical care interventions has an area under the curve of 0.74 (95% CI 0.70 to 0.77).[Nishijima DK et al., 2012, level II-2]

There is a significant association between death and age (OR=1.04), GCS (OR=0.59), ISS (OR=1.03), mean arterial BP (OR=0.71) and RR (OR=0.82) in patients with TBI.[Saadat et.al., 2012, level III]

Recommendation 6

- Initial assessment and management of patients with head injury in emergency department includes:
  - airway patency and cervical spine protection
  - breathing
  - circulation and haemorrhage control
  - disability including Glasgow Coma Scale, pupil size and reaction to light
  - exposure including log roll
- Head chart which includes serial Glasgow Coma Scale, blood pressure, pulse rate and pupil size should be done at least hourly.
  - Look for signs of intracranial hypertension such as decrease pupil response to light, hypertension with bradycardia, posturing or respiratory abnormalities.
- Secondary survey (head to toe examinations) should be done in patient with head injury which includes signs of base of skull fracture*.

*Refer to **Chapter 2** on **Definition Base of Skull Fracture**

6.3 Observation in ED

TBI is one of the common reasons for ED visit. Most TBIs are mild and self-limiting. However they usually require further observation after initial systematic assessment and treatment. The primary aim is to detect promptly patients who deteriorate neurologically and to ensure safe home discharge.

Early imaging, rather than admission and observation for neurological deterioration, will reduce the time to detection for life-threatening complications and is associated with better outcomes.[Fabrri A et al., 2004, level II-2] Patients with MHI (who do not have criteria for CT scan) can be managed in ED. The management at ED observation wards is efficient at dealing with short stay observation patients.[NICE, 2014]

6.3.1 Patients who can be observed safely in ED

Patients with MHI (who do not have criteria for head CT) can be managed in the ED observation ward.

In the management of head injury, patients with GCS score of 15 and normal neurological findings who either have CT scan performed immediately or routine observation have similar extended Glasgow outcome score (GOS) at three months follow-up.[af Geijerstam JR et al., 2006, level I]

In a RCT, all adult patients with mild TBI (GCS 13 - 15), without a history of inherited coagulopathy or anticoagulant therapy, platelet aggregation inhibitor therapy, intoxication or multiple associated injuries, who present with a single ICH with maximum diameter <5 mm regained full GCS within two hours. These patients may not require 24 - hour observation.[Schaller B et al., 2010, level I]

Patients with MHI and ICH of $\leq$4 mm, normal neurological examination, no skull fracture, not on any warfarin, aspirin or clopidogrel, and not intoxicated, can be safety observed for six hours without neurosurgical consultation.[Joseph B et al., 2014, level III]

Patients with minor head injury (GCS 15), $\geq$65 years old, on low dose aspirin with systolic blood pressure <150 mmHg and presenting with initial negative primary head CT, should have a routine repeat head CT within 12 - 24 hours to accurately identify or subjected to a prolonged hospital observation for at least 48 hours.[Tauber M et.al., 2009, level III]

Recommendation 7

- Patients with mild head injury without CT scan and with all the following criteria can be safely observed in emergency department* for a minimum of six hours:
  - Glasgow Coma Scale score 15 on arrival or two hours later
  - no neurological abnormality
  - age <65 years old
  - not on any anticoagulant or antiplatelet therapy
  - no history of coagulopathy
  - no multiple injuries
  - not intoxicated and not under influence of psychotropic drugs

*For hospital without observation ward these patients may be admitted.

7.3.2 Parameters for observation in ED

Emergency care providers (ECP) should use a standard head injury parameters and proforma in their documentation when assessing and observing patients with TBIs. (Refer to **Appendix 4** on **Head Chart**)

It is well established that the risk of intracranial complications and subsequent need for surgery increases as GCS score declines. Extensive studies have supported their repeatability and validity.[SIGN, 2009]

Prospective observational study comparing GCS score of patients done on the field with the one obtained by emergency physicians upon arrival in ED showed a moderate relationship (r=0.45, p=0.003). Assuming most GCS scores improve from field to ED, there is concordance between ECP and physicians in assessment of TBI patients using the GCS.[Bazarian et al, 2003, level III]

Variables that are highly accurate in predicting clinically significant outcomes of mild TBI patients include GCS (OR=11.74, 95% CI 8.42 to 16.37), neurological deficit (OR=1.90, 95% CI 1.33 to 2.71), clinical findings [such as amnesia, diffuse headache, vomiting and LOC (OR=4.31, 95% CI 2.81 to 6.61)], skull fracture (OR=31.01, 95% CI 20.36 to 47.21) and risk factors [such as coagulopathy, age >60 years old, previous neurosurgery, PTS and alcohol/drug abuse (OR=2.12, 95% CI 1.62 to 3.01)].[Fabrri A et al., 2004, level III]

In patients with TBI, the significant risk factors for mortality are increasing age, lower GCS, higher ISS, lower mean arterial BP and abnormal RR (>25 and <10).[Saadat S et al., 2012, level III]

In patients with head injury admitted for observation, the minimum acceptable documented neurological observations are GCS, pupil size and reactivity, limb movements, RR, HR, BP, temperature and blood oxygen saturation.[NICE, 2014] Even though the evidence is based on patients admitted for observation in hospital, the same principles apply to patients observed in ED.

- All healthcare providers caring for patients with head injury should be capable of performing the observations effectively.
- The acquisition and maintenance of observation and recording skills require dedicated training and this should be available to all relevant staff.
- When using GCS, document and communicate each response (for example a patient scoring 13/15 based on scores of 4 on eye-opening, 4 on verbal response and 5 on motor response should be communicated as E4, V4, M5) with a denominator of 15.

Recommendation 8

- The following parameters should be used for observation of patients with head injury:
  a) Glasgow Coma Scale and Score
  b) Vital signs
     - Respiratory rate and oxygen saturation
     - Pulse rate
     - Blood pressure
     - Pain score
     - Temperature
  c) Neurological deficits
     - Pupil size and reactivity
     - Limb movement
     - Unusual behaviour, temperament or speech impairment
  d) Other symptoms such as persistent vomiting, seizure, amnesia and diffuse headache

Refer to **Appendix 4** on **Head Chart**.

6.3.2 Method, frequency and duration of observation/assessment in ED

There is insufficient evidence on method, frequency and duration of observation/assessment of head injury in ED. In management of head injury, pre-emptive investigation to detect lesions before they lead to further neurological deterioration has superseded the earlier deterioration dependent approach.[SIGN, 2009]

i. Method

A safe assessment of TBI in ED requires a consistency of observation and re-evaluation as the injury is dynamic.[SIGN, 2009]

- During handover of patient care, ECP should communicate with healthcare providers in ED on details of the mechanism and type of injury, and records of neurological progress since arrival in ED.
- Head chart should be used to monitor patients' progress. Any discrepancy in assessment should be discussed immediately with the senior medical officer or EP.

ii. Frequency

Frequency of observation should relate to risk of clinically important findings in order to detect early deterioration of head injury.

The risk of rapid deterioration due to intracranial complications is high during the first six hours and diminishes after that. Therefore, observations should be more frequent during this period.[NICE, 2014]

Patients with MHI who is admitted to neurosurgery ward for observation should not die. At present, hourly observation of MHI patient is a standard practice in Malaysia. Monthly reports of Malaysian National Indicator Approach on MHI case fatality rate show a consistent result of <1%.[Report KPI Medical Program, 2015.]

Patients with a head injury, who warrant admission, should have neurological observations carried out at least in the following frequency starting after initial assessment in the ED:[SIGN, 2009]

- half hourly for two hours
- hourly for four hours
- two hourly for six hours

- four hourly thereafter until agreed to be no longer necessary

Perform and record observations on a half-hourly basis until GCS 15 has been achieved. Thereafter, the minimum frequency of observation are as follows:[NICE, 2014]

- half-hourly for two hours
- hourly for next four hours
- 2-hourly thereafter
- should there be any deterioration at any time after the initial 2-hour period, observations should revert to half-hourly and follow the original frequency schedule

iii. Duration

Patients with MHI can be safety observed for six hours without neurosurgical consultation if they have the following features:[Joseph B et al., 2014, level III]

- ICH of ≤4 mm
- normal neurological examination
- no skull fracture
- not on any warfarin, aspirin or clopidogrel
- not intoxicated

Patient who have been provided with emergency care and having clinical and/or physiological conditions that are expected to deteriorate or resolve and require close observation may be admitted to ED observation ward. These patients should have a pre-defined care plan within stipulated time frame of 8 hours or prerogative of EP in charge as clinically indicated.[EMTS Policy, MOH Malaysia, 2012, level III]

Recommendation 9

- Patients with head injury should be monitored and recorded immediately using head chart.
  - Any deterioration should prompt immediate re-evaluation of the patients by the attending doctor.
- Observations may be performed and documented hourly in head injury patients. Should there be any deterioration at any time after the initial 2-hour period, the minimum frequency of observation respectively are as follows until GCS 15 is achieved:
  - half-hourly for first two hours
  - hourly for next four hours
  - 2-hourly for six hours
  - 4-hourly thereafter until no longer necessary and/or fit for discharge
- Patients with mild head injury can be safely observed in emergency department for a minimum of six hours without CT scan.

6.3.3 Admission post-observation in ED

The primary reasons for in-hospital admission post-observation in ED is for further management of patients who develop worsening post-concussion symptoms or presence of features indicating risk of further complications. Patients with persistent impaired consciousness or neurological impairment will need continued observation and in-patient care. [NICE, 2014]

Some clinical risk factors can be used as a guide to identify those who need neurosurgical intervention. In pre-injury warfarin and clopidogrel use, the risk factors for ICH are vomiting (OR=3.68, 95% CI 1.55 to 8.76) and abnormal mental status (OR=3.08, 95% CI 1.60 to 5.94). [Nishijima DK et al., 2013, level III.] GCS (OR=11.74, 95% CI 8.42 to 16.37), neurological deficit (OR=1.90, 95% CI 1.33 to 2.71), clinical findings [such as amnesia, diffuse headache, vomiting and LOC (OR=4.31, 95% CI 2.81 to 6.61)], skull fracture (OR=31.01, 95% CI 20.36 to 47.21) and risk

factors [such as coagulopathy, age >60 years old, previous neurosurgery, post-trauma seizure (PTS) and alcohol/drug abuse (OR=2.12, 95% CI 1.62 to 3.01)] was found to be highly accurate in predicting clinically significant outcomes of mild TBI patients.[Fabrri A et al., 2004, level III]

CT can be used as a safe modality to triage patients for admission as it leads to similar clinical outcomes compared with observation in hospital.[Af Geijerstam JL et al., 2006, level I]

The criteria below are used for admitting patients to hospital following a head injury:[NICE, 2014]

- Patients with new, clinically significant abnormalities on imaging.
- Patients whose GCS has not returned to 15 after imaging, regardless of the imaging results.
- When a patient has indications for CT scanning but this cannot be done within the appropriate period, either because CT is not available or because the patient is not sufficiently cooperative to allow scanning.
- Continuing worrying signs (for example, persistent vomiting, severe headaches) of concern to the clinician.
- Other sources of concern to the clinician (for example, drug or alcohol intoxication, other injuries, shock, suspected non-accidental injury, meningism, cerebrospinal fluid leak).

An adult patient with MHI should be admitted to hospital if:[SIGN, 2009]

- the level of consciousness is impaired (GCS <15/15)
- the patient is fully conscious (GCS 15/15) but has any indication for a ct scan (if the scan is normal and there are no other reasons for admission, then the patient may be considered for discharge)
- the patient has significant medical problems e.g. anticoagulant use
- the patient has social problems or cannot be supervised by a responsible adult.

Recommendation in this section is formulated based on extrapolation from other guidelines and tailored to local context.

Recommendation 10

- Patients with mild head injury who have been observed for six hours in emergency department should be admitted if they have:
  - clinical significant abnormalities on head CT imaging if it is performed
  - Glasgow Coma Scale Score <15*
  - worrying signs (e.g. vomit ≥2 times, seizure, diffuse headache, amnesia, abnormal behavior or neurological deficit)*
  - other body system injuries requiring admission
  - social problems or no supervision by a responsible adult

*Patients should have a head CT before admission

6.3.5 Discharge from ED without observation

It is neither feasible nor desirable to admit all MHI patients attending ED for observation especially those who have recovered and at low risk of intracranial complications. Furthermore, patients with MHI who present with a GCS of 15 to the ED rarely require urgent neurosurgical intervention or experience precipitous deterioration.[Clement CM et al., 2006, level II-2]

Patients with low risk MHI can be discharge after assessment without observation. Low risk patients are those with:[Fabrri A et al., 2004, level II-2]

- GCS of 15
- no clinical finding (amnesia, vomiting, diffuse headache and LOC)
- no neurological deficit

- no skull fracture
- no risk factors (coagulopathy, age <60 years, previous neurosurgery, pre-trauma epilepsy and/or alcohol and/or drug misuse)

- Criteria to be met by patients of head injury prior to discharge:
  - Presence of willing responsible adult for at least 24-hour observation
  - Verbal and written discharged advice given to responsible caregivers and discussed prior to discharge
  - Easy access to an emergency response system e.g. 999
  - Living within reasonable access to medical care.
  - Availability of home transport.

Adapted from: Scottish Intercollegiate Guidelines Network. Early management of patients with a head injury: Edinburgh; 2009.

Recommendation 11
- Patient with low risk mild head injury* can be discharged safely without observation from emergency department or primary care with reliable care giver.

*Refer to preceding paragraph.

7. IMAGING

Management of moderate and severe TBI depends largely on imaging of head and neck to detect intracranial lesions. Early imaging prevents deterioration of patients' condition due to expansion of intracranial lesions and expedites appropriate surgical and medical interventions. Exclusion or demonstration of intracranial injury can guide decision about extent and duration of observation in TBI.

7.1 Head CT

In current practice, the used of head CT in head injury has been used with no uniform guidelines. There is tendency to under investigate MHI when there are limited resources.

There are a few head CT rules available to guide the need for CT scan. Canadian CT Head Rule (CCTHR) is used to select patients with MHI (GCS 13-15) for CT head. CCTHR identifies five high risk factors (refer to yellow box below) which predict neurological intervention [sensitivity of 100% (95% CI 92 to 100%) and specificity of 68.7% (95% CI 62 to 70)].[Stiell IG et al., 2001, level II-2]

CCTHR also identifies two medium-risk factors (refer to yellow box below) which predict clinically important brain injury [sensitivity 98.4% (95%CI 96 to 99%) and specificity 49.6% (95% CI 48 to 51%)].[Stiell IG et al., 2001, level II-2]

However, CCTHR is not applicable in the presence of seizure, penetrating skull injury, focal neurological deficit and use of anticoagulant.[Stiell IG et al., 2001, level II-2]

The New Orleans Criteria (NOC) derived a set of clinical findings to identify a group of minor head injury patients who need CT scan. Presence of any the following findings will identify positive head CT [sensitivity of 100% (95% CI 95 to 100%) and specificity of 25% (95% CI 22 to 28%)]:[Haydel MJ et al., 2000, level II]
- headache

- vomiting
- age >60 years
- drug or alcohol intoxication
- deficits in short-term memory
- physical evidence of trauma above the clavicles
- seizure

Both CCHTR and NOC had been externally validated in detecting all patients who require neurosurgical intervention in two studies. For CCTHR, the sensitivities remained the same but with variable specificities (37.2% and 58%). For NOC, the sensitivities were also high (96% and 100%) but specificities were low (5.3% and 26%).[Bouida W et al., 2013, level II-2; Smits M et al., 2005, level II -2]

Scandinavian Neurotrauma Committee has concluded that the presence of the following criteria warrants admission head CT:[Undén J et al., 2013]

- mild and moderate head injury with GCS ≤14
- loss of consciousness
- repeated (≥2) vomiting
- anticoagulant therapy or coagulation disorders
- clinical signs of depressed or basal skull fracture
- PTS
- focal neurological deficits

There is no retrievable evidence on the timing of CT scan. However, the SIGN guideline list down factors for immediate (within one hour) and urgent (within eight hours) CT scan in head injury. The timing for CT scan in MHI for local context is based on expert opinion of DG CPG.

Canadian CT Head Rule

CT Head Rule is only required for patients with minor head injuries and any of the following:

A. High risk (for neurological intervention)
   - GCS score <15 at two hours after injury
   - Suspected open or depressed skull fracture
   - Any sign of basal skull fracture (haemotympanum, 'racoon' eyes, cerebrospinal fluid otorrhoea/rhinorrhoea, Battle's sign)
   - Vomiting >two episodes
   - Age ≥65 years

B. Medium risk (for brain injury on CT)
   - Amnesia before impact >30 minutes
   - Dangerous mechanism (pedestrian struck by motor vehicle, occupant ejected from motor vehicle, fall from height >three feet or five stairs)

Minor head injury is defined as witnessed loss of consciousness, definite amnesia or witnessed disorientation in a patient with a GCS score of 13 - 15.

Patients on anticoagulation or antiplatelet therapy have a positive head CTs of 29% despite having a GCS score of 15. LOC is a predictor of a positive CT result (p=0.008), suggesting that head CT should be strongly considered in these patients.[Brewer ES et al., 2011, level III]

In polytrauma patients with TBI, a priority for the initial management including timing of head CT is not straightforward. Neurologic examination of patients with hypotension is unreliable. Intracranial haemorrhage cannot cause haemorrhagic shock, except in the terminal stages when medullary failure supervenes or there is a concomitant spinal cord injury. Primary source of the hypotension must be urgently sought and treated, e.g. patients with exsanguinations intra-abdominal injuries should be operated on and stabilised before obtaining head CT.[ATLS, 2012]

Recommendation 12

- Canadian Computed Tomography Head Rule (CCTHR) may be used to decide on the need of Computed Tomography (CT) of the head in mild head injury (MHI).
- Patients with MHI on anticoagulation and/or antiplatelet should be considered for head CT.
- Urgency* for head CT in head injury patients should be based on severity of the injury and risk factors.
- Patients' cardiopulmonary status should be stabilised before performing head CT.

*Refer to the preceding text.

7.2 Skull X-ray

The definitive imaging for head injury is head CT. The scan is indicated when there is anatomical and/or physiological evidence of head injury. In MHI group with GCS of 15, asymptomatic and no neurological deficit, external evidences of head injury especially skull fracture are important observation to decide if a head CT is warranted prior to a definitive management plan.

Skull fractures may occur in the cranial vault or skull base. They may be linear or comminuted, and open or closed. Open fracture is diagnosed when any of the following is present:[ATLS, 2012]

- obvious evidence of penetrating head injury (involving skull bone and structure beneath it)
- skull fracture visualised beneath scalp laceration wound
- clinical signs suggestive of skull base fracture such as periorbital ecchymosis ("Raccoon's eyes"), retro-auricular ecchymosis ("Battle's sign"), cerebrospinal fluid leakage either from the nose [cerebral spinal fluid (CSF) rhinorhoea] or ear (CSF otorhoea), or seventh and eighth cranial nerves deficits causing facial paralysis and hearing loss respectively

Closed fracture is diagnosed when skull depression is detected by scalp palpation with or without overlying scalp swelling or hematoma.

Skull fracture is an important finding to predict intracranial lesion following MHI which warranted a head CT.

- If skull fracture present, the probability of an ICH is 4.9 times higher than those without skull fracture.[Hofman PA et al., 2000, level III]
- Skull fracture, with or without clinical signs, in MHI is an independent risk marker of neurosurgically relevant intracranial lesion (RR=3.9, 95% CI 2.2 to 7.1).[Muñoz-Sánchez MA et al., 2009, level II-2]

Head CT is the investigation of choice to identify ICH following head injury. The plain skull x-ray is ineffective screening tool in predicting ICH in MHI with a mean sensitivity of 50.0% (ranges from 13.0% to 75.0%) and a mean specificity of 97.0% (ranges from 91.0% to 99.5%).[Hofman PA et al., 2000, level III.]

Skull fracture can only be ruled out by radiographic imaging such as skull x-ray and head CT. In the absence of clinical signs of skull fracture, one cannot rule out the presence of skull fracture. This is because the sensitivities and specificities of clinical signs are low compared to radiographic imaging, as shown in the **Table 2** below.[Muñoz-Sánchez MA et al., 2009, level II-2]

Table 2. Sensitivity and specificity of clinical assessment on skull fracture

Clinical findings	Sensitivity	Specificity
Clinical assessment (both clinical signs of skull fracture and scalp wound)	51.6%	71.4%
Clinical signs of skull fracture alone with absence of scalp wound	36.1%	87.5%
Scalp wound alone	15.4%	50.0%

If CT scan is not immediately available and patient does not fulfil clinical criteria for CT scan of head, a skull x-ray can be performed. The patients should undergo CT scan of head if skull x-ray is positive.[Muñoz-Sánchez MA et al., 2009, level II-2]

Recommendation 13
- Skull x-ray may be done in mild head injury patients who do not fulfil the criteria for CT scan of head*.

*Refer to the **Chapter 7.1** on **CT scan indications**

7.3 Repeat Head CT

Given the high cost and radiation risk associated with head CT, the practice of routine repeat CT scan of patients with TBI need to be addressed.

In a recent meta-analysis of 16 cohort studies, the intervention rates were higher in patients with MHI who had CT scan done based on neurological deterioration compared with those who had routine repeat CT regardless of neurological changes (2.7% vs 0.6%, p<0.001). The findings suggest that it is unnecessary to repeat a CT scan after MHI when neurological status remain unchanged or improves.[Almenawer SA et al., 2012, level II-2] Neurologic examination is an independent predictor on the need for neurosurgical intervention in patients with TBI who are not on antiplatelet or anticoagulation therapy (OR=3.98, 95% CI 1.7 to 9.1).[Bellal Joseph et al., 2014, level II-2]

Patients with MHI who are ≥65 years old and on low dose aspirin, with initial negative primary head CT, have secondary ICH accurately identified in routine repeat head CT within 12 hours to 24 hours (p<0.00001). For those who do not have a repeat scan, they are subjected to prolonged in-hospital observation for at least 48 hours.[Tauber M et. al., 2009, level III]

In another meta-analysis of low quality cohort studies, repeat CT in patients with TBI resulted in change of management for a minority of patients. Better designed studies are needed to address the value of repeat CT in the management of TBI.[Reljic T et al., 2014, level II-2]

- There is insufficient evidence to recommend routine repeat head CT in MHI.

7.4 Cervical Imaging

- All patients with head injury are presumed to have cervical spine injury until proven otherwise. Protection of the cervical spine in these patients is a priority.

Assessment for the need of cervical spine imaging in patients with head injury depends on their conscious level and ability to cooperate in clinical examination. Two independent decision rules [Canadian Cervical Spine Rule (CCR) and National Emergency X-radiography Utilization Study (NEXUS)] are available to assist such assessment. Refer to **Appendix 6** and **Appendix 7** on CCR and NEXUS criteria.

In a study comparing these two decision rules of cervical radiography, CCR was more sensitive (99.4% vs 90.7%, p<0.001) and more specific (45.1% vs 36.8%, p<0.001) than Nexus criteria for detection of cervical spine injury in alert and stable patients with trauma to the head and neck. The use of CCR when compared with Nexus criteria resulted in lower radiography rates (55.9% vs 66.6%, p<0.001).[Stiell IG et al., 2003, level I]

Validation of the CCR, using CT scan as a gold standard, to identify cervical spine fracture demonstrated that CCR was very sensitive (100%) but had very low specificity (0.60%). The study evaluated 19 of the 20 clinical findings described in the CCR excluding 45° rotation of the neck and found eight predictors of cervical spine fracture which were:[Duane TM et al., 2011, level III]

- midline tenderness
- GCS <15
- age ≥65 year
- paraesthesia
- high speed motor vehicle collision (MVC) 100 km/hour
- rollover MVC
- MVC with ejection/ejection
- never in sitting position in ED

In another study, several factors were significantly associated with cervical spine injury (CSI) in patients with TBI. Patients in the older age group (>65 years old) have a higher odds ratio of CSI when compared to younger age patients in MVA but not in fall related injuries (OR=1.26, 95% CI 1.15 to 1.39). Skull/face fracture, other spine fracture/dislocation, upper limb injury, thorax injury, and hypotension were significantly associated with CSI (OR range from 32 to 3.34).[Fujii T et al., 2013, level III]

The incidence of CSI in patients with blunt polytrauma and reduced levels of consciousness (GCS <15) ranges between 5.2% and 13.9%.[Thomas M et al., 2002] In a meta-analysis of seven studies, cervical CT was more sensitive (98%, 95% CI 96 to 99) than cervical spine plain radiography (52%, 95% CI 47 to 56) in detecting CSI.[Holmes JF et al., 2005, level I] Thus, it is a good practice to include cervical spine when performing head CT.

Recommendation 14

- Canadian Cervical Spine Rule (CCR) or National Emergency X-radiography Utilization Study (NEXUS) criteria may be used as selection criteria for cervical radiograph in alert and stable head injury patients.
- Patient who has Glasgow Coma Scale <15 with indication for Head Computed Tomography, scanning should include cervical spine.

8. MEDICATION IN INITIAL MANAGEMENT

Medications used in initial management of TBI are analgesia, sedation, anticonvulsant, and diuretic. A variety of pharmacological agents have been recommended to treat agitation, minimise painful and noxious stimuli as they may potentially contribute to elevation in ICP, BP, and body temperature. [AANS/CNS, 2008, level III]. Diuretic used to control raised ICP and anticonvulsant

to control early seizures. IV fluid is administered to restore and maintain the systemic and cerebral perfusion.

8.1 Analgesia/Sedation

- Sedative/analgesic agents are commonly administered in adults with TBI for one or more of the following indications:
  - to induce anxiolysis
  - to control agitation/restlessness
  - to control pain
  - to facilitate mechanical ventilation
  - to improve intracranial pressure (ICP) and cerebral perfusion pressure (CPP)

A systematic review showed that etomidate and propofol improved ICP and CPP in adults with severe TBI. Boluses or short infusions of opioids such as fentanyl and morphine resulted in clinically and statistically significant increases in ICP and decreases in MAP and CPP. However, there was no strong evidence to support that one agent was more efficacious than another for improvement of favourable neurologic outcome (defined as a GOS score of 4 to 5, mortality rate and others.[Roberts DJ et al., 2011, level I] In a meta-analysis on severe TBI, there was no difference between propofol and midazolam in GOS (OR=1.139, 95% CI 0.397 to 3.273) and mortality (OR=0.758, 95% CI 0.237 to 2.424).[Gu JW et al., 2014, level I]

A Cochrane systematic review revealed no significance in mortality and severe disability between barbiturate and control group. However, barbiturate therapy resulted in increased occurrence of hypotension (OR=1.8, 95% CI 1.19 to 2.7) which offset any ICP lowering effect on CPP and lowered the mean body temperature.[Roberts I et al., 2012, level I] This is supported by a large, multicentre cohort study which showed high dose barbiturate decreased ICP but also caused hemodynamic instability leading to increased use of high doses of vasopressors in severe TBI. Thiopental and methohexital were equally effective in the patient's GOS.[Majdan M et al., 2013, level III]

In a meta-analysis of 19 RCTs, naloxone was safe to be used in severe TBI in terms of mortality, ICP and prognosis.[Zafar SN et al., 2012, level I]

There is no retrieval evidence on the use of analgesia/sedation/reversal in mild to moderate head injury. However, DG of the CPG is of the opinion that this issue should be addressed based on expert opinion.

8.2 Intravenous Fluid

In patients with TBI, resuscitation fluids are fundamental components of the restoration and maintenance of the systemic and cerebral perfusion.

A systematic review found no evidence to support the use of hyperosmolar crystalloid or colloid solutions over isotonic crystalloids for pre-hospital fluid resuscitation of patients with TBI.[Tan PG et al., 2011, level I] In a RCT, fluid resuscitation with albumin was associated with higher mortality rates and fewer favourable neurologic outcomes when compared with saline in severe TBI patients in ICU.[Myburgh J et al., 2007, level I]

A systematic review found only one RCT showing no significant differences in mortality and morbidity between pre-hospital and delayed fluid resuscitation (mean transfer time to hospital of 19 minutes).[Tan PG et al., 2011, level I]

8.3 Diuretic

Mannitol is widely used in the control of raised ICP following brain injury. However, there is uncertainty over the optimal treatment regimen, the effectiveness of mannitol as compared with other ICP lowering agents and the usefulness of mannitol given at other stages following head injury, for example in the pre-hospital setting prior to volume resuscitation.

A Cochrane systematic review showed that mannitol therapy for raised ICP had no significant beneficial or detrimental effect on mortality when compared with pentobarbital or hypertonic saline. ICP-directed treatment had small beneficial effect compared to treatment directed by neurological signs and physiological indicators. However, there was insufficient evidence on the efficacious of pre-hospital administration of mannitol.[Wakai A et al., 2013, level I]

In view of insufficient evidence on the use of IV fluid regime for resuscitation in PHC and the important of the issue to be addressed, the CPG DG formulates the recommendations based on their expert opinion.

8.4 Anticonvulsant

PTS is defined as a recurrent seizure disorder due to TBI. PTS can be divided into three groups: immediate seizure (occurring within 24 hours of injury), early seizure (occurring within seven days of injury) and late seizure (occurring more than seven days after injury). The peak incidence of early PTS occurs within the initial 48 hours of the causative head injury.[Grisar T et al., 2005,level III]

The incidence of early and late PTS without antiepileptic prophylaxis has been estimated from 4% to 25% and 9% to 42% respectively.[AANS/CNS, 2008] Effective prophylaxis of early PTS reduces brain metabolic demands, therefore reducing intracranial pressure and neurotransmitter release. This can prevent secondary brain injury.[Brain Injury Special Interest Group of the American Academy of Physical Medicine and Rehabilitation, 1998, level III]

The risk factors for PTS include:[Khan AA et al., 2010, level I]

- GCS score <10/15
- cortical contusions
- depressed skull fractures
- early intracranial haematoma
- wounds with dural penetration (epidural or subdural)
- prolonged length of coma (>24 hours)
- prolonged length of post-traumatic amnesia (>24 hours)
- damage in the region adjacent to the temporal sulcus

In a systematic review, IV prophylactic phenytoin administered within eight hours of injury (ideally in the first one hour) was efficacious in reducing the incidence of early PTS in moderate to severe head injury.[Khan AA et al., 2010, level I]

There is no significant difference between levetiracetam and phenytoin with regards to seizure rate, adverse drug reaction, complication and mortality. The cost and need for serum monitoring should be considered in choosing early PTS prophylactic agent.[Inaba K et al., 2013, level II-2]

Recommendation 15

- Analgesia/sedation should be used in severe head injury who are intubated and ventilated.
- In mild to moderate head injury:
  - analgesic should be offered when it is indicated
  - short-acting sedative agent may be offered in titrated dose to control agitation/restlessness
- Naloxone may be used as opioid reversal in head injury.
- Isotonic crystalloid is the preferred choice of fluid in head injury.
- Mannitol, hypertonic saline or frusemide may be used to reduce intracranial pressure in head injury after consultation with a specialist.
  - Diuretics should not be used in hypotensive patients.
- Phenytoin should be given as prophylaxis against early post-traumatic seizure in head injury with risk factors*.

*Refer to preceding paragraph.
Refer Appendix 11 on **Drug Dosing Regimen for Initial Management**

9. Special Consideration

9.1 Reversal of Antiplatelet and Anticoagulant in Patients with Head Injury

Patients with pre-injury use of antiplatelet agents (e.g. clopidogrel and aspirin) are at an increased risk for mortality with blunt traumatic ICH.[Wong DK et al., 2008, level III] It is prudent to achieve rapid control of haemorrhage as the haemorrhagic expansion in traumatic ICH occurs within the first 24 hours after injury[Narayan PK et al., 2008, level III] and proven to be an independent predictor of mortality.[Davis SM et al., 2006, level III]

The transfusion of platelet in patients with mild TBI does not significantly increase cardiac and pulmonary events, or mortality compared with patients without transfusion. It is also not significantly associated with progression of injury based on imaging. Combined transfusion of platelet, fresh frozen plasma and/or factor VII is associated with medical decline, specifically cardiac and respiratory events (OR=5.8, 95% CI 1.2 to 28.2).[Washington CW et al., 2011, level II-3]

A systematic review of five articles on the utility of platelet transfusion in adults with pre-injury antiplatelet and traumatic ICH showed inadequate evidence to support the routine use of platelet transfusion in the ED. There was higher mortality among these patients.[Nishijima DK et al., 2012, level II-2]

There is insufficient evidence to recommend routine transfusion of platelet in patients with MHI and on antiplatelet therapy.

Anticoagulant-associated ICH has a high risk of bleeding expansion, disability or death. Pre-injury use of warfarin is a significant predictor of mortality in patients with traumatic ICH. The important aspect of management of anticoagulant-associated ICH is urgent reversal of coagulopathy with rapid decrease of the International Normalized Ratio (INR) to a value of <1.4, preferably to <1.2. Interventions aimed at preventing the haematoma expansion are paramount as larger haematomas are associated with poorer functional outcomes.[Davis SM et al., 2006, level III]

International consensus-based guidelines emphasise immediate discontinuation of anticoagulant and reversal of anticoagulation in ICH by administration of vitamin K, fresh frozen plasma (FFP), prothrombin complex concentrate (PCC) or recombinant factor VIIa as indicated.

However there is no specific target INR for adequate reversal in ICH patients on oral anticoagulant therapy.[Ansell J et al., 2008, level III]

In a review of treatments for reversing warfarin anticoagulation in patients with acute ICH, PCC was statistically faster than FFP in correcting INR. Recombinant factor VIIa rapidly reversed the effect of warfarin on INR with a reported 5% thromboembolic risk. Commonly used drug vitamin K was slow in onset, carried a risk of allergic reaction and should be given slowly to all patients with warfarin-associated ICH. Despite the multiple treatment options available, the review did not demonstrate an improved patient survival with any particular treatment option.[Bechtel BF et al., 2011, level III]

A study of 13 coagulopathic patients with traumatic ICH treated with recombinant factor VIIa demonstrated that rapid correction of INR threshold to 1.3 prevented expansion of bleeding and facilitated urgent surgical intervention.[Bartal C at al., 2006, level II-3]

Recommendations 16

- Anticoagulant should be immediately stopped and reversed in patients with intracranial bleeding using vitamin K, fresh frozen plasma, prothrombin complex concentrate or recombinant factor VIIa as indicated and should be consulted among relevant specialties.

9.2 Restarting Antiplatelet/Anticoagulant in Patients with Head Injury

Reinitiating warfarin therapy in a patient with recent warfarin associated intracranial haemorrhage (WAICH) is a challenging decision for the physician. The risks include the reoccurrence of ICH once warfarin is restarted versus the risk of thromboembolism without warfarin therapy. Careful control of anticoagulation level decreases the risk of ICH.[Broderick J, 2007, level III]

A long-term clinical study indicated that recurrent WAICH is uncommon when anticoagulant therapy is resumed. The end point of thromboembolic events and WAICH is not statistically significant between those restarted and not restarted on warfarin (p=0.62). Clinical decision to resume anticoagulant therapy after WAICH should include patient's general medical condition, risk of falls and risk factors for systemic haemorrhage. Patients without these risks may benefit from restarting warfarin therapy. Failure to resume therapy may subject the patient to thromboembolic complications.[Claassen DO et al., 2008, level III]

A systematic review concluded that it may be advisable to reinitiate anticoagulation earlier with the timing and intensity modified based on predictors of thromboembolic and haemorrhagic complications. The predictors for haemorrhagic complications are:[Hawryluk GW et al., 2009, level II-2]

- younger patients (p<0.0001)
- traumatic causes (p=0.002)
- subdural haemorrhage (p=0.049),
- patients anticoagulated for cardiac indications (p=0.0047)
- anticoagulation with warfarin and aspirin (OR=2.825, 95% CI 0.766 to 10.414)
- failure to reverse anticoagulation (OR= 3.633, 95% CI 1.431 to 9.226)

Predictors for thromboembolic complications are:[Hawryluk GW et al., 2009, level II-2]

- younger patients (p=0.048)
- spinal haemorrhage, multiple haemorrhage and non-traumatic causes (p=0.046)
- anticoagulation started at lower intensity (p=0.0001)

Without prophylaxis 39% of patients develop deep venous thrombosis. This risks increases with the addition of other organ injuries. Enoxaparin can be considered as an option for early venous thromboembolism (VTE) prophylaxis in selected patients with blunt TBI.[Scott H et al, 2008, level III]

There are limited evidence to recommend the timing to restart antiplatelet and anticoagulant in patients with TBI.

9.3 Patients with Head Injury Requiring Early Non-Urgent Extracranial Surgery

Certain injuries are not immediately life-threatening but can lead to morbidity and mortality with delay in its management such as femur fracture co-existing with head injury.[Nau T et al., 2003, level III]

Reported benefits of early long-bone stabilisation in polytrauma patients include increased patient mobilisation by eliminating the need for traction and reducing pulmonary morbidity, hospital care costs, mortality, hospital length of stay, intensive care unit and ventilator days.[Dunham CM et al., 2001, level II-2]

The concerns for patients with head injury include:-

- possibility of induced-secondary brain injury
- timing for performing non-urgent surgery
- interruption in GCS monitoring for patients while undergone anaesthesia
- MHI with no indication for a CT scan but require surgery

Delayed ICH should be considered in patients who do not regain full consciousness or develop new neurological deficit post anaesthesia.

As the types of non-urgent surgery is limitless and choices aplenty, the CPG DG has decided to use compound fracture of the femur as a surrogate indicator. It is probably the most major among non-life- or limb-threatening surgeries. Urgent intervention for a compound injury is to prevent osteomyelitis.[Nau T et al., 2003, level III]

There is no retrievable evidence on indications for CT scan in patients with MHI who do not fulfil the CCHTR criteria but require urgent surgery. The decision on the need of CT scan should be made by a multidisciplinary team.

Early fixation of long bone fracture under general anaesthesia (GA) in patients with head injury is an acceptable practice. In multisystem trauma patients with TBI and chest injury, early timing of orthopaedic femur fracture fixation under GA is not associated with worse outcome than those without femur fracture and no surgery.[Wang MC et al., 2007, level III] Orthopaedic and facial fracture fixation under GA (<24 hours) is not associated with worse neuropsychological or functional outcome than late surgery. As there is no evidence that early stabilisation has any detrimental effect, it is preferable to perform early long-bone stabilisation in polytrauma patients.[Wang et al., 2007, level II-2]

The period of greatest risk for delayed ICH (causing significant morbidity and mortality) following trauma is the first six hours.[SIGN, 2009]

Recommendation 17

- Early extracranial surgery in head injury patients can be performed safely under general anaesthesia.

9.4 Safe Extubation of Patients with Head Injury

Patients may have to be pre-emptively intubated for certain situations (e.g. intoxicated, restlessness and for radiological or diagnostic procedures). However, there may be a need to extubate these patients after that. Extubation of these patients demands consideration of airway patency, respiratory parameters, neurological status and associated injury. Points to be considered include timing and place of extubation, and post-extubation care.

There is limited evidence on the above issues. A cohort study showed that it was safe to extubate patients in ED provided that certain rules and criteria were followed.[Weingart SD et al., 2011, level III]

Pre-extubation:[Weingart SD et al., 2011, level III]

- resolution of the clinical issue requiring intubation
- Fraction of inspired oxygen (FiO2) $\leq$40%, Positive end-expiratory pressure (PEEP) $\leq$5cm H_2O
- SpO_2 >95%, SBP >100 mmHg, HR <130 bpm
- patient not known to be a difficult intubation

Post-extubation

- patient should receive close monitoring for at least 60 minutes

A person trained in airway and ventilator management preferably anaesthesiologist or EP should carry out the extubation.

In view of limited evidence, the following points are to be considered prior to extubation.

- Equipments for intubation with trained person in airway management should be readily available.
- At least six hours post-extubation close observation (SpO_2, BP, PR, RR and sign of hypoxia or airway compromise) is performed.
- When in doubt, extubation should not be attempted.
- Patients are preferably placed in High Dependency Unit (HDU) or Critical Care Area.

*Refer to **Appendix 10** on **Safe Extubation Criteria in Head Injury.**

A RCT study showed the independent predictors for successful extubation in neurosurgical patients were GCS score ($p<0.0001$) and partial pressure of arterial oxygen/fraction of inspired oxygen ratio ($p<0.0001$).[Namen AM et al., 2001, level I]

10. TELECONSULTATION

Observation in a general hospital with telemedicine facilities does not put patients with mild to moderate head injury and positive CT scan at a significant risk provided there are:-[Fabbri A et al, 2008, level II-2]

- careful initial assessment,
- continuous observation and
- easy access to neurosurgery in the event of progression

Teleconsultation avoids unnecessary transfer of one third of patients with head injury (34%). It changes the treatment at the referring hospital on the advice of the neurosurgeon (42%).[Stormo A et al, 2004, level II-3]

A local study showed that teleradiology significantly reduced the number of inter-hospital transfer by 37%. However 20.1% of patients who were not transferred based on clinical data alone would have to be transferred when the clinical data and images were reviewed. On

multiple logistic regression analysis, MHI was twice as likely to be transferred if both clinical data and images were reviewed compared with clinical data alone.[Hassan R et al., 2014, level III]

iPad is equally efficacious as LCD monitor in interpretation of radiologic images during teleconsultation (AUC of 0.900 and 0.935 respectively, p=0.183).[Park JB et al, 2013, level II-3]

Recommendation 18
- Teleconsultation should be used in the management of head injury if available.

- Patients' confidentiality must always be upheld at all times when utilising teleconsultation.

11. DISCHARGE ADVICE

It is important to give careful verbal and written discharge advice to patients with head injury and their care givers. This will help them to identify alarming features that need immediate medical attention and those who need post-concussion rehabilitation.[Kerr J et al., 2007, level III; Wade DT et al., 1998, level I] The discharge form should include facilities contact details in the event of emergency or related queries.[Fung M et al., 2006, level III]

A standardised head injury discharge advice that is well versed by the staff is beneficial.[Kerr J et al., 2007, level III] Factors that may influence the comprehension of the advice are age group, years of schooling, literacy level and simplicity of the discharge form.[Yates K et al., 2006, level I] Therefore a discharge form should be standardised and comprehensible at all levels. Patient with minor TBI may be discharged from ED provided there is responsible care givers that could comprehend the given discharge advice.[Heng KW et al, 2007, level III]

- All patients or their caregivers should be given verbal and written discharge advice.
- They should be asked to repeat the advice to ensure that they understand upon discharge.

A careful discharge instruction should include alarming features as follows:[Fung M et al., 2006, level III]
- GCS <15 (unable to open eye spontaneously, disorientated or unable to obey command)
- vomiting
- headache
- amnesia
- seizure
- neurological deficit

Recommendation 19
- Head injury discharge advice form should be comprehensible and include alarming features and contacts of local healthcare facilities*.

*Refer to **Appendix 5**.

12. FOLLOW-UP

Patients with minor head injury can be followed up by telephone conversation within 48 hours on their ability to recall alarming features and well-being.[Heng KW et al., 2007, level III] Early rehabilitation significantly aids patients with MHI who continue to experience difficulties with everyday activities.[Wade DT et al., 1997, level I]

Patients with moderate or severe head injury should be discharged with routine follow-up. Rehabilitation programme improves patients' condition by reducing social disabilities and post concussion symptoms.[Wade DT et al., 1998, level I]

Recommendation 20
- Moderate to severe head injury should have scheduled clinic follow-up.
- Mild head injury may have follow-up via clinic visit or telephone call.

13. IMPLEMENTINGTHE GUIDELINES

The management of head injury should be guided by evidence-based approach in order to provide quality care to the patients. Several factors may affect the implementation of recommendations in the CPG.

13.1 Facilitating and Limiting Factors

Existing facilitators for application of the recommendations in the CPG include:
1. wide dissemination of the CPG (soft- and hard-copies) to healthcare providers
2. regular update on HI management at conferences and scientific meeting locally

Existing barriers for application of the recommendations of the CPG are:
1. evolving understanding of the illness and its treatment
2. insufficient resources for integrated care at different level of service delivery
3. variation in treatment practice and preferences
4. no national registry for HI for further planning of services

13.2 Potential Resource Implications

To implement the CPG, there must be strong commitment to:-
1. ensure widespread distribution of the CPG to healthcare providers via printed and electronic copies
2. reinforce regular training with adequate funding of healthcare providers
3. ensure trained multidisciplinary team is available at different levels of healthcare
4. ensure widespread distribution of updated patient education materials

The following is proposed as **clinical audit indicator for quality management**:-

Percentage of isolated mild head injury initially treated as inpatient and died
Standard: <5%

$$= \frac{\text{Number of patients with isolated mild head injury initially treated as inpatient and died on admission within 1 year study period}}{\text{Number of isolated mild head injury initially treated as inpatient and died on admission in the same period}} \times 100\%$$

Inclusion criteria: All MHI who are treated at all healthcare facilities

Implementation strategies will be developed following the approval of the CPG by MOH. They are such as a Quick Reference and a Training Module.

REFERENCES

1. af Geijerstam JL, Oredsson S, Britton M; OCTOPUS Study Investigators. Medical outcome after immediate computed tomography or admission for observation in patients with mild head injury: randomised controlled trial. BMJ. 2006 Sep 2;333(7566):465.
2. Ahn H, Singh J, Nathens A, MacDonald RD et al. Pre-hospital care management of a potential spinal cord injured patient: a systematic review of the literature and evidence-based guidelines. J Neurotrauma. 2011 Aug;28(8):1341-61.
3. Almenawer SA, Bogza I, Yarascavitch B, et al. The value of scheduled repeat cranial computed tomography after mild head injury: single-center series and meta-analysis. Neurosurgery. 72. 2013;1(56-62):discussion 63-64.
4. American College of Surgeon Committee on Trauma. Advanced Trauma Life Support Student Course Manual (9^{th} Edition). Chicago: 2012.
5. Ansell J, Hirsh J, Hylek E, et al ; American College of Chest Physicians. Pharmacology and management of the vitamin K antagonists: American College of Chest Physicians Evidence-Based Clinical Practice Guidelines (8th Edition). Chest. 2008 Jun;133(6 Suppl):160S-198S.
6. Association of Anesthetists of Great Britain and Ireland. Recommendations for the Safe Transfer of Patients with Brain Injury. London: AAGBI; 2006.
7. Austin N, Krishnamoorthy V, Dagal A. Airway management in cervical spine injury. International Journal of Critical Illness and Injury Science. 2014;4(1):50-56.
8. Ayson M. Best-evidence Review of Transfer Protocols for Moderate to Severe Traumatic Brain Injury. ACC: 2011.
9. Badjatia N, Carney N, Crocco TJ, et al. Brain Trauma Foundation; BTF Center for Guidelines Management. Guidelines for prehospital management of traumatic brain injury 2nd edition. Prehosp Emerg Care. 2008;12 Suppl 1:S1-52
10. Barmparas G, Liou DZ, Lamb AW, et al. Prehospital hypertension is predictive of traumatic brain injury and is associated with higher mortality. J Trauma Acute Care Surg. 2014;77(4):592-598.
11. Bartal C, Freedman J, Bowman K, et al. Coagulopathic patients with traumatic intracranial bleeding: defining the role of recombinant factor VIIa. J Trauma. 2007;63(4):725-732.Bazarian JJ, Eirich MA, Salhanick SD. The relationship between pre-hospital and emergency department Glasgow coma scale scores. Brain Inj. 2003 Jul;17(7):553-60.
12. Bechtel BF, Nunez TC, Lyon JA, et al. Treatments for reversing warfarin anticoagulation in patients with acute intracranial hemorrhage: a structured literature review. Int J Emerg Med. 2011.8;4(1):40.
13. Bouida W, Marghli S, Souissi S, et al. Prediction value of the Canadian CT head rule and the New Orleans criteria for positive head CT scan and acute neurosurgical procedures in minor head trauma: a multicenter external validation study. Ann Emerg Med. 2013;61(5):521-527.
14. Brain Trauma Foundation; American Association of Neurological Surgeons; Congress of Neurological Surgeons; Joint Section on Neurotrauma and Critical Care, AANS/CNS, Bratton SL, Chestnut RM, Ghajar J, McConnell Hammond FF, Harris OA, Hartl R, Manley GT, Nemecek A, Newell DW, Rosenthal G, Schouten J, Shutter L, Timmons SD, Ullman JS, Videtta W, Wilberger JE, Wright DW. Guidelines for the management of severe traumatic brain injury. II. Hyperosmolar therapy. J Neurotrauma. 2007;24 Suppl 1:S14-20. Erratum in: J Neurotrauma. 2008 Mar;25(3):276-8.
15. Brewer ES, Reznikov B, Liberman RF, et al. Incidence and predictors of intracranial hemorrhage after minor head trauma in patients taking anticoagulant and antiplatelet medication. J Trauma. 2011;70(1):E1-5.
16. Broderick J, Connolly S, Feldmann E, et al.; American Heart Association; American Stroke Association Stroke Council; High Blood Pressure Research Council; Quality of Care and Outcomes in Research Interdisciplinary Working Group. Guidelines for the management of

spontaneous intracerebral hemorrhage in adults: 2007 update: a guideline from the American Heart Association/American Stroke Association Stroke Council, High Blood Pressure Research Council, and the Quality of Care and Outcomes in Research Interdisciplinary Working Group. Stroke. 2007 Jun;38(6):2001-23.
17. Carney N, Ghajar J, Jagoda A, et al. Concussion guidelines step 1: systematic review of prevalent indicators. Neurosurgery. 2014;75 Suppl 1:S3-15.
18. CDC's Injury Center: Traumatic Brain Injury, How Many People Have TBI?; Department of Veteran's Affairs (VA) and the Department of Defense (DoD) (Department of Veteran's Affairs, Department of Defense 2009); Tintinalli's Emergency Medicine: A Comprehensive Study Guide, Seventh Edition (Emergency Medicine (Tintinalli)) 7th Edition; 2011.
19. Chan Chi Ho Clinical predictors of minor head injury patients presenting with Glasgow Coma Scale score of 14 or 15 and requiring neurosurgical intervention Hong Kong j.emerg.med. 2010;17: 256-261
20. Chowdhury T, Kowalski S, Arabi Y, et al. Pre-hospital and initial management of head injury patients: An update. Saudi J Anaesth. 2014 Jan;8(1):114-20.
21. Davis SM, Broderick J, Hennerici M, et al ; Recombinant Activated Factor VII Intracerebral Hemorrhage Trial Investigators. Hematoma growth is a determinant of mortality and poor outcome after intracerebral hemorrhage. Neurology. 2006 Apr 25;66(8):1175-81.
22. Claassen DO, Kazemi N, Zubkov AY, et al. Restarting anticoagulation therapy after warfarin-associated intracerebral hemorrhage. Arch Neurol. 2008;65(10):1313-1318.
23. Clement CM, Stiell IG, Schull MJ, et al. Clinical Features of Head Injury Patients Presenting With a Glasgow Coma Scale Score of 15 and Who Require Neurosurgical Intervention. Annals of Emergency Medicine. 2006;48(3):245-251.
24. Drug Information Handbook, 22th ed. Hudson, Ohio, Lexi-Comp, Inc.;2013:1143-7.
25. Duane TM, Wilson SP, Mayglothling J, et al. Canadian Cervical Spine rule compared with computed tomography: a prospective analysis. J Trauma. 2011;71(2):352-355.
26. Dunham CM, Bosse MJ, Clancy TV, et al. EAST Practice Management Guidelines Work Group. Practice management guidelines for the optimal timing of long-bone fracture stabilization in polytrauma patients: the EAST Practice Management Guidelines Work Group. J Trauma. 2001;50(5):958-967.
27. Eastridge BJ, Salinas J, McManus JG, et al. Hypotension Begins at 110 mm Hg: Redefining "Hypotension" With Data. The Journal of Trauma: Injury, Infection, and Critical Care. 2007;63(2):291-299
28. Fabbri A, Servadei F, Marchesini G, et al. Observational approach to subjects with mild-to-moderate head injury and initial non-neurosurgical lesions. J Neurol Neurosurg Psychiatry. 2008;79(10):1180-1185.
29. Fabbri A, Servadei F, Marchesini G, et al. Prospective validation of a proposal for diagnosis and management of patients attending the emergency department for mild head injury. J Neurol Neurosurg Psychiatry. 2004;75(3):410-416.
30. Fabbri A, Servadei F, Marchesini G, et al. Which type of observation for patients with high-risk mild head injury and negative computed tomography? Eur J Emerg Med. 2004 Apr;11(2):65-74.
31. Flower O, Hellings S. Sedation in traumatic brain injury. Emerg Med Int. 2012;2012:637171
32. Fujii T, Faul M, Sasser S, et al. Risk factors for cervical spine injury among patients with traumatic brain injury. J Emerg Trauma Shock. 2013;6(4):252-258.
33. Fung M, Willer B, Moreland D, et al. A proposal for an evidenced-based emergency department discharge form for mild traumatic brain injury. Brain Inj. 2006;20(9):889-894.
34. Gray SH, Ross JA, Green RS. How to safely extubate a patient in the emergency department: a user's guide to critical care. CJEM. 2013 Sep;15(5):303-6.
35. Grisar T, Bottin P, de Borchgrave d'Alténa V, et al. Prophylaxis of the epilepsies: should anti-epileptic drugs be used for preventing seizures after acute brain injury? Acta Neurol Belg. 2005;105(1):5-13.

36. Gu JW, Yang T, Kuang YQ, et al. Comparison of the safety and efficacy of propofol with midazolam for sedation of patients with severe traumatic brain injury: a meta-analysis. J Crit Care. 2014;29(2):287-290.
37. Hassan R, Siregar JA, A Rahman Mohd NA. The implementation of teleneurosurgery in the management of referrals to a neurosurgical department in hospital sultanah amninah johor bahru. Malays J Med Sci. 2014 Mar;21(2):54-62.
38. Hawryluk GW, Austin JW, Furlan JC, et al. Management of anticoagulation following central nervous system hemorrhage in patients with high thromboembolic risk. J Thromb Haemost. 2010;8(7):1500-1508.
39. Haydel MJ, Preston CA, Mills TJ, et al. Indications for computed tomography in patients with minor head injury. N Engl J Med. 2000 343(2):100-105.
40. Health Informatic Centre, Planning Division, MOH, Malaysia. Health Indicators 2014: Indicators for Monitoring and Evaluation of Strategy Health for All.
41. Health Informatics Centre. Health Facts 2015; Ministry of Health, Malaysia, 2015.
42. Heng KW, Tham KY, How KY, et al. Recall of discharge advice given to patients with minor head injury presenting to a Singapore emergency department. Singapore Med J. 2007 48(12):1107-1110.
43. Hofman PA, Nelemans P, Kemerink GJ, et al. Value of radiological diagnosis of skull fracture in the management of mild head injury: meta-analysis. J Neurol Neurosurg Psychiatry. 2000 68(4):416-422.
44. Holmes JF, Akkinepalli R. Computed tomography versus plain radiography to screen for cervical spine injury: a meta-analysis. J Trauma. 2005;58:902-905.
45. Hsiao KY, Hsiao CT, Weng HH, et al. Factors predicting mortality in victims of blunt trauma brain injury in emergency department settings. Emergency Medicine Journal. 2008;25(10):670-673.
46. Hussain LM, Redmond AD. Are prehospital deaths from accidental injury preventable? British Medical Journal 1994;308:1077-1080.
47. Inaba K, Menaker J, Branco BC, et al. A prospective multicenter comparison of levetiracetam versus phenytoin for early posttraumatic seizure prophylaxis. J Trauma Acute Care Surg. 2013;74(3):766-771.
48. Jamaluddin SF et al. National Trauma Database January 2009 to December 2009 Fourth Report; NTrD and CRC; July 2011.
49. Jennett B, Teasdale G. Aspects of coma after severe head injury. Lancet. 1977;23;1(8017):878-959.
50. Joseph B, Friese RS, Sadoun M, et al. The BIG (brain injury guidelines) project. Journal of Trauma and Acute Care Surgery. 2014;76(4):965-969.
51. Joseph B, Pandit V, Meyer D, et al. The significance of platelet count in traumatic brain injury patients on antiplatelet therapy. J Trauma Acute Care Surg. 2014 Sep;77(3):417-21.
52. Kerr J, Swann IJ, Pentland B. A survey of information given to head-injured patients on direct discharge from emergency departments in Scotland. Emerg Med J. 2007;24(5):330-332.
53. Khan AA, Banerjee A. The role of prophylactic anticonvulsants in moderate to severe head injury. Int J Emerg Med. 2010;3(3):187-278.
54. Lerner EB, Roberts J, Guse CE, et al. Does EMS Perceived Anatomic Injury Predict Trauma Center Need? Prehospital Emergency Care. 2013;17(3):312-316.
55. Ley EJ, Srour MK, Clond MA, et al. Diabetic patients with traumatic brain injury: insulin deficiency is associated with increased mortality. J Trauma. 2011;70(5):1141-1144.
56. Livingston DH, Lavery RF, Passannante MR, et al. Emergency department discharge of patients with a negative cranial computed tomography scan after minimal head injury. Ann Surg. 2000 Jul;232(1):126-158.
57. Majdan M, Mauritz W, Wilbacher I, et al. Barbiturates use and its effects in patients with severe traumatic brain injury in five European countries. J Neurotrauma. 2013;30(1):23-29.
58. Medical Development Division. Country Health Plan 10th Malaysia Plan 2011-2015; Ministry of Health, Malaysia.

59. Medical Development Division. Specialty and subspecialty Framework of Ministry of Health hospitals 10 MP (2010-2015); Ministry of Health, Malaysia; Dec 2011.
60. Muñoz-Sánchez MA, Murillo-Cabezas F, Cayuela-Domínguez A, et al. Skull fracture, with or without clinical signs, in mTBI is an independent risk marker for neurosurgically relevant intracranial lesion: a cohort study. Brain Inj. 2009;23(1):39-44.
61. Nakahara S, Matsuoka T, Ueno M, et al. Predictive Factors for Undertriage Among Severe Blunt Trauma Patients: What Enables Them to Slip Through an Established Trauma Triage Protocol? The Journal of Trauma: Injury, Infection, and Critical Care. 2010;68(5):1044-1051.
62. Namen AM, Ely EW, Tatter SB, et al. Predictors of successful extubation in neurosurgical patients. Am J Respir Crit Care Med. 2001 Mar;163(3Pt 1):658-64.
63. Narayan RK, Maas AI, Servadei F, et al. Traumatic Intracerebral Hemorrhage Study Group. Progression of traumatic intracerebral hemorrhage: a prospective observational study. J Neurotrauma. 2008 Jun;25(6):629-39.
64. Nau T, Aldrian S, Koenig F, et al. Fixation of femoral fractures in multiple-injury patients with combined chest and head injuries. ANZ J Surg. 2003 Dec;73(12):1018-21.
65. Nishijima DK, Offerman SR, Ballard DW, et al. Risk of Traumatic Intracranial Hemorrhage In Patients With Head Injury and Preinjury Warfarin or Clopidogrel Use. Academic Emergency Medicine. 2013;20(2):140-145.
66. Nishijima DK, Shahlaie K, Echeverri A, et al. A clinical decision rule to predict adult patients with traumatic intracranial haemorrhage who do not require intensive care unit admission. Injury. 2012;43(11):1827-1832.
67. Nishijima DK, Zehtabchi S, Berrong J, et al. Utility of platelet transfusion in adult patients with traumatic intracranial hemorrhage and preinjury antiplatelet use: a systematic review. J Trauma Acute Care Surg. 2012;72(6):1658-1663.
68. Observational Medicine. Emergency Medicine and Trauma Services Policy. Medical Development Division, Ministry of Health Malaysia 2012. ISBN 978-967-0399-04-1.
69. Park JB, Choi HJ, Lee JH, et al. An assessment of the iPad 2 as a CT teleradiology tool using brain CT with subtle intracranial hemorrhage under conventional illumination. J Digit Imaging. 2013 26(4):683-690.
70. Pearson WS, Ovalle F, Faul M, et al. A Review of Traumatic Brain Injury Trauma Center Visits Meeting Physiologic Criteria from the American College of Surgeons Committee on Trauma/Centers for Disease Control and Prevention Field Triage Guidelines. Prehospital Emergency Care. 2012;16(3):323-328.
71. Peck KA, Calvo RY, Schechter MS, et al. The impact of preinjury anticoagulants and prescription antiplatelet agents on outcomes in older patients with traumatic brain injury. J Trauma Acute Care Surg. 2014;76(2):431-436.
72. Peggy J. Parks. Concussions (Compact research series). 2014. Reference Point Press, Inc.
73. Practice parameter: antiepileptic drug treatment of posttraumatic seizures. Brain Injury Special Interest Group of the American Academy of Physical Medicine and Rehabilitation. Arch Phys Med Rehabil. 1998 May;79(5):594-7.
74. Practice parameter: the management of concussion in sports (summary statement). Report of the Quality Standards Subcommittee. Neurology. 1997 ;48(3):581-586.
75. Raj R, Siironen J, Kivisaari R, et al. Factors correlating with delayed trauma center admission following traumatic brain injury. Scand J Trauma Resusc Emerg Med. 2013;21:67.
76. Reljic T, Mahony H, Djulbegovic B, et al. Value of repeat head computed tomography after traumatic brain injury: systematic review and meta-analysis. J Neurotrauma. 2014 31(1):78-98.
77. Report on Mild Head Injury Case Fatality Rate 2015. Key Performance Indicator Medical Programme 2012, Medical Development Division, Ministry of Health Malaysia.
78. Roberts DJ, Hall RI, Kramer AH, et al. Sedation for critically ill adults with severe traumatic brain injury: a systematic review of randomized controlled trials. Crit Care Med. 2011;39(12):2743-2751.

79. Roberts I, Sydenham E. Barbiturates for acute traumatic brain injury. Cochrane Database Syst Rev. 2012 Dec 12;12:CD000033
80. Ryynänen O-P, Iirola T, Reitala J, et al. Is advanced life support better than basic life support in prehospital care? A systematic review. Scandinavian Journal of Trauma, Resuscitation and Emergency Medicine. 2010;18(1):62.
81. Saadat S, Akbari H, Khorramirouz R, et al. Determinants of mortality in patients with traumatic brain injury. Turkish Journal of Trauma and Emergency Surgery. 2012;18(3):219-224.
82. SAFE Study Investigators; Australian and New Zealand Intensive Care Society Clinical Trials Group; Australian Red Cross Blood Service; George Institute for International Health, Myburgh J, Cooper DJ, Finfer S, Bellomo R, Norton R, Bishop N, Kai Lo S, Vallance S. Saline or albumin for fluid resuscitation in patients with traumatic brain injury. N Engl J Med. 2007 Aug 30;357(9):874-84.
83. Schaller B, Evangelopoulos DS, Muller C, et al. Do we really need 24-h observation for patients with minimal brain injury and small intracranial bleeding? The Bernese Trauma Unit Protocol. Emergency Medicine Journal. 2010;27(7):537-539.
84. Scottish Intercollegiate Guidelines Network. Early management of patients with a head injury. SIGN: Edinburgh; 2009.
85. Sethi D, Aljunid S, Saperi SB at al. Comparison of the effectiveness of trauma services provided by secondary and tertiary hospitals in Malaysia. Ann Emerg Med. 2007 Jan;49(1):52-61
86. Shahin H, Gopinath SP, Robertson CS. Influence of Alcohol on Early Glasgow Coma Scale in Head-Injured Patients. The Journal of Trauma: Injury, Infection, and Critical Care. 2010;69(5):1176-1181.
87. Smits M, Dippel DW, de Haan GG, et al. External validation of the Canadian CT Head Rule and the New Orleans Criteria for CT scanning in patients with minor head injury. JAMA. 2005;294(12):1519-1525.
88. Statistic on road traffic accidents 2013 by Malaysian Police Force. Available at http://trafik.rmp.gov.my/copsportal/ (accessed 14th October 2015)
89. Stiell IG, Clement CM, McKnight RD, et al. The Canadian C-spine rule versus the NEXUS low-risk criteria in patients with trauma. N Engl J Med. 2003 349(26):2510-2518.
90. Stiell IG, Wells GA, Vandemheen K, et al. The Canadian CT Head Rule for patients with minor head injury. Lancet. 2001 357(9266):1391-1396.
91. Stormo A, Sollid S, Størmer J, et al. Neurosurgical teleconsultations in northern Norway. J Telemed Telecare. 2004;10(3):135-139.
92. Tan PG, Cincotta M, Clavisi O, et al. Prehospital fluid management in traumatic brain injury. Emerg Med Australas. 2011 Dec;23(6):665-76.
93. Tan PG, Cincotta M, Clavisi O, et al. Review article: Prehospital fluid management in traumatic brain injury. Emerg Med Australas. 2011;23(6):665-676.
94. Tauber M, Koller H, Moroder P, et al. Secondary Intracranial Hemorrhage After Mild Head Injury in Patients With Low-Dose Acetylsalicylate Acid Prophylaxis. The Journal of Trauma: Injury, Infection, and Critical Care. 2009;67(3):521-525.
95. Technical Committee of Malaysian Registry of Intensive Care. 6th Report of Malaysian Registry of Intensive Care 2008; Ministry of Health, Malaysia; May 2009.
96. The National Institute for Health and Care Excellence. Triage, assessment, investigation and early management of head injury in children, young people and adults. UK: NICE; 2014.
97. Thomas M, Teece S. Towards evidence based emergency medicine: best BETs from Manchester Royal Infirmary. Computed tomography and the exclusion of upper cervical spine injury in trauma patients with altered mental state. Emerg Med J 2002;19(6):551-2.
98. Timmons SD, Bee T, Webb S, et al. Using the Abbreviated Injury Severity and Glasgow Coma Scale Scores to Predict 2-Week Mortality After Traumatic Brain Injury. The Journal of Trauma: Injury, Infection, and Critical Care. 2011;71(5):1172-1178.

99. Tohme S, Delhumeau C, Zuercher M, et al. Prehospital risk factors of mortality and impaired consciousness after severe traumatic brain injury: an epidemiological study. Scand J Trauma Resusc Emerg Med. 2014;7:22:21.
100. Undén J, Ingebrigtsen T, Romner B, et al. Scandinavian Neurotrauma Committee (SNC). Scandinavian guidelines for initial management of minimal, mild and moderate head injuries in adults: an evidence and consensus-based update. BMC Med. 2013;11:50.
101. Von Elm E, Schoettker P, Henzi I, et al. Pre-hospital tracheal intubation in patients with traumatic brain injury: systematic review of current evidence. Br J Anaesth. 2009 Sep;103(3):371-86.
102. Wade DT, Crawford S, FJ W, et al. Does routine follow up after head injury help? A randomised controlled trial. J Neurol Neurosurg Psychiatry. 1997;62(5):478-484.
103. Wade DT, King NS, Wenden FJ, et al. Routine follow up after head injury: a second randomised controlled trial. J Neurol Neurosurg Psychiatry. 1998;65(2):177-183.
104. Wakai A, Roberts I, Schierhout G, et al. Mannitol for acute traumatic brain injury. Cochrane Database Syst Rev. 2007;24(1):CD001049.
105. Wang MC, Temkin NR, Deyo RA, et al. Timing of surgery after multisystem injury with traumatic brain injury: effect on neuropsychological and functional outcome. J Trauma. 2007;62(5):1250-1258.
106. Washington CW, Schuerer DJ, Jr. GR. Platelet transfusion: an unnecessary risk for mild traumatic brain injury patients on antiplatelet therapy. J Trauma. 2011;71(2):358-363.
107. Weingart SD, Menaker J, Truong H, et al. Trauma patients can be safely extubated in the emergency department. J Emerg Med. 2011 Feb;40(2):235-9.
108. World Health Organization. Global status report on road safety 2013: supporting a decade of action. WHO Press.
109. Yates K, Pena A. Comprehension of discharge information for minor head injury: a randomised controlled trial in New Zealand. N Z Med J. 2006 Aug 4;119(1239):U2101
110. Zafar SN, Khan AA, Ghauri AA, et al. Phenytoin versus Leviteracetam for seizure prophylaxis after brain injury - a meta analysis. BMC Neurol. 2012;12:30.

EXAMPLE OF SEARCH STRATEGY

The following MeSH terms or free text terms were used either singly or in combination, search was limit to English, human and last 10 years:-

Population for OVID

1. Craniocerebral Trauma/
2. (traum* adj1 (craniocerebral or cranial or frontal region or frontal or parietal region or parietal or temporal region or temporal or occipital region or occipital or forehead or head or skull or posterior fossa)).tw.
3. (traum* adj1 (occipital or parietal or frontal)).tw.
4. (head injur* adj1 (multiple or superficial or minor or open or closed)).tw.
5. (injur* adj1 (cranial or head or craniocerebral or multiple head or superficial head or minor head or open head or skull)).tw.
6. Skull Fractures/
7. (skull adj1 fracture*).tw.
8. (skull fracture* adj1 (linear or non depressed or non-depressed)).tw.
9. (fracture* adj1 (non-depressed skull or non depressed skull linear skull or compound skull)).tw.
10. Brain Injuries/
11.(injur* adj1 (traum* brain or mild traum* brain or brain traum* mild or diffuse brain or focal brain or acute brain or brain)).tw.
12. (brain injur* adj1 (traum* or acute or focal or diffuse)).tw.
13.(encephalopath* adj1 (post concussive or post-concussive or traum* or post-traum* or post traum*)).tw.
14.(brain adj1 (traum* or laceration* or contusion*)).tw.
15. (cortical adj1 contusion*).tw.
16. traum* brain injury.tw.
17. tbi*.tw.
18. Diffuse Axonal Injury/
19. (injur* adj1 diffuse axonal).tw.
20. diffuse axonal injury.tw.
21. axonal injur* diffuse.tw.
22. Post-Concussion Syndrome/
23. ((post concuss* or post-concuss*) adj1 (syndrome* or symptom*)).tw.
24. Brain Concussion/
25. (concussion* adj1 (cerebral or brain or severe or mild or moderate or intermediate)).tw.
26. Skull Fracture, Depressed/
27. (compound depressed adj1 skull fracture*).tw.
28. (skull fracture* adj1 depressed).tw.
29. Multiple Trauma/
30.((injur* or wound* or traum*) adj1 multiple).tw.
31. polytrauma*.tw.
32. Contrecoup Injury/
33. (injur* adj1 (contre-coup or contre coup or contrecoup)).tw.
34. Brain Hemorrhage, Traumatic/
35. (h?emorrhage* adj1 (traumatic cerebellar or traum* brain)).tw.
36. (traum* adj1 (cerebellar h?emorrhage* or brain h?emorrhage*)).tw.
37. Brain Stem Hemorrhage, Traumatic/
38. (traum* adj1 (brainstem h?em* or brain stem h?em* or bulbar h?em* or medullary h?em* or pontine h?em* or midbrain h?em* or h?em* brain stem or h?em* brainstem)).tw.
39. (h?em* adj1 (traumatic medullary or traumatic bulbar or post-traumatic brainstem)).tw.
40. Cerebral Hemorrhage, Traumatic/
41. (traum* adj1 (cerebral h?em* or intracerebral h?em* or cerebral parenchymal h?em* or brain h?em* cerebral or cerebral intraparenchymal h?em*)).tw.
42. (h?em* traum* adj1 (intracerebral or cerebral)).tw.
43. Epilepsy, Post-Traumatic/
44. (seizure* adj1 (disorder* post traum* or disorder* post-traum* or early post-traum* or early post traum* or impact)).tw.
45. ((post-traum* seizure* or post traum* seizure*) adj1 (disorder* or early)).tw.
46. (epileps* adj1 (post-traum* or post traum* or traum*)).tw.
47. (concussive adj1 convulsion*).tw.
48. Pneumocephalus/
49. (pneumocephalus adj1 (traum* or tension or pressure)).tw.
50. Cerebrospinal Fluid Otorrhea/
51.((otorrh?ea or rhinorrh?ea*) adj1 (post-traum* cerebrospinal fluid or post traum* cerebrospinal fluid or cerebrospinal fluid traum* or traum* cerebrospinal fluid or cerebrospinal fluid post- traum*)).tw.
52. (cerebrospinal fluid adj1 (post-traum* otorrh?ea or post traum* otorrh?ea or otorrh?ea traum* or traum* otorrh?ea or otorrh?ea post-traum* or otorrh?ea post traum* or post-traum* rhinorrh?ea* or post traum* rhinorrh?ea* or rhinorrh?ea* traum* or traum* rhinorrh?ea* or rhinorrh?ea* post-traum* or rhinorrh?ea* post traum*)).tw.
53.Cerebrospinal Fluid Rhinorrhea/
54.Coma, Post-Head Injury/
55.(coma* adj1 (post-traum* or post traum* or post-head injury or post head injury or post-concussive or post concussive)).tw.
56. Head Injuries, Closed/
57. ((head injur* or head traum*) adj1 (closed or nonpenetrating or blunt or penetrating)).tw.
58. ((traum* or injur*) adj closed head).tw.
59. OCULOMOTOR NERVE INJURIES/
60. ((traum* or injur*) adj1 (third-nerve or third nerve or third-nerve palsy or third nerve palsy or oculomotor nerve or oculomotor neuropath* or third cranial nerve or cranial nerve iii or second-nerve or second nerve or second-nerve palsy or second nerve palsy or optic nerve or optic neuropath* or second cranial nerve or cranial nerve ii)).tw.
61. ((oculomotor or optic) adj (nerve traum* or nerve injur*)).tw.
62. Optic Nerve Injuries/
63. HEAD INJURIES, PENETRATING/
64. (penetrating adj1 (craniocerebral traum* or brain traum* or brain injur* or cranial traum* or head traum* or head injur*)).tw.
65. ((traum* or injur*) adj1 (penetrating head or penetrating cranial or penetrating craniocerebral)).tw.
66. Intracranial Hemorrhage, Traumatic/
67. (intracranial h?em* adj traum*).tw.
68. (traum* intracranial adj1 h?em*).tw.
69. Brain Hemorrhage, Traumatic/
70. ((traum* cerebellar or traum* brain) adj1 h?em*).tw.
71.(traum* adj1 (brain h?em* or cerebellar h?em*)).tw.
72.HEMATOMA, EPIDURAL, CRANIAL/
73.((cranial or intracranial) adj1 (extradural h?em* or epidural h?em*)).tw.
74. HEMATOMA, SUBDURAL/
75. (subdural adj1 h?em*).tw.
76. (traum* adj1 subdural h?em*).tw.
77. HEMATOMA, SUBDURAL, ACUTE/
78. (subdural adj1 h?em* acute).tw.
79. (h?em* adj1 (acute subdural or subdural acute)).tw.
80.HEMATOMA, SUBDURAL, INTRACRANIAL/
81. (subdural h?em* adj2 (intracranial or traum*)).tw.
82.(subdural adj1 h?em* intracranial).tw.
83. (h?em* adj1 (subdural intracranial or subdural cranial or intracranial subdural)).tw.
84. Skull Fracture, Basilar/
85. ((frontobasilar or basilar) adj1 skull fracture*).tw.
86. (fracture* adj1 basilar skull).tw.
87.(battle* adj1 sign).tw.
88.Subarachnoid Hemorrhage, Traumatic/
89.((traum* or post-traum* or post traum*) adj1 subarachnoid h?em*).tw.
90. (h?em* adj (traum* or post-traum* or post traum*)).tw.

92. COMBINATION OF POPULATION
93. (prehospital adj1 emergency care).tw.
94. ((pre-hospital or primary care) adj (assess* or evaluat*)).tw.
95. Abbreviated Injury Scale/
96. (abbreviated adj1 injur* scale*).tw.
97. Injury Severity Score/
98. iss score*.tw.
99. injur* severity score*.tw.
100. score* injury severity.tw.
101. GLASGOW COMA (coma adj1 scale Glasgow).
102. coma scale Glasgow.tw.
103. Glasgow Coma Scale.tw.
104. 92 or 93 or 94 or 95 or 96 or 97 or 98 or 99 or 100 or 101 or 102 or 103
105. 90 and 104

92. COMBINE OF POPULATION
93. tomography, x-ray computed/ or tomography, spiral computed/ or multidetector computed tomography/
94. (helical adj1 ct*).tw.
95. ((compute*-assisted or compute* assisted or compute*) adj1 (tomography spiral or tomography helical)).tw.
96. (spiral adj1 (c?t scan* or compute* tomography or ct*)).tw.
97. (scan* adj1 spiral c?t*).tw.
98. (tomography adj1 (spiral compute* or spiral compute*-assisted or helical computed)).tw.
99. ((ct scan* or cat scan* or ct) adj1 (x-ray* or x ray* or cine)).tw.
100. ((scan* x-ray* or scan x ray*) adj (ct or cat)).tw.
101. (tomodensitometry.tw.
102. (tomograph* adj1 (x-ray* compute* or x ray* compute* or xray* compute* or electron beam or compute* x-ray* or compute* x ray* or compute* xray* or transmission compute*)).tw.
103. ((compute* tomograp* or tomograp* compute*) adj1 (x-ray* or x ray* or xray* or transmission)).tw.
104. ((x-ray* compute* or xray* compute* or x ray* compute* or electron beam compute*) adj1 (assisted tomograph* or tomograph* or axial tomograph*)).tw.
105. tomograph* x ray* or tomograph* xray* or tomograph* x-ray*) adj1 (compute* assisted or compute* axial)).tw.
106. tomography multisection computed.tw.
107. tomography multidetector-row computed.tw.
108. ((multidetector row or multidetector-row or multidetector or multislice or multisection) adj1 computed tomography).tw.
109. tomography multislice computed.tw.
110. tomography multidetector computed.tw.
111. 92 or 93 or 94 or 95 or 96 or 97 or 98 or 99 or 100 or 101 or 102 or 103 or 104 or 105 or 106 or 107 or 108 or 109
112. 91 and 110

92. COMBINE POPULATION
93. (anticoagulant adj1 agent*).tw.
94. anticoagulant*.tw.
95. (thrombin inhibitor adj1 indirect).tw.
96. Inhibitors indirect thrombin.tw.
97. PLATELET AGGREGATION INHIBITORS/
98. (antiplatelet adj1 drug*).tw.
99. (platelet adj1 antogonist*).tw.
100. Blood platelet adj1 antagonist*).tw.
101. antiplatelet agent*.tw.
102. Anticoagulants/
103. (platelet adj1 inhibitor*).tw.
104. (blood platelet adj1 antiaggregrant*).tw
105. (platelet adj1 antiaggregant*).tw.
106. blood platelet aggregation inhibitor*.tw.
107. platelet aggregation inhibitors.tw.
108. Aspirin/
109. (acid adj1 acetylsalicylic).tw.
110. aspirin.tw.
111. Ticlopidine/
112. ticlopidine.tw.
113. (ticlopidine adj1 hydrochloride).tw
114. ticlid.tw.
115. 93 or 94 or 95 or 96 or 97 or 98 or 99 or 100 or 101 or 102 or 103 or 104 or 105 or 106 or 107 or 108 or 109 or 110 or 111 or 112 or 113 or 114
116. 91 and 115

APPENDIX 2

CLINICAL QUESTIONS

1. What is the definition of head injury?
2. What are the conditions to consider in suspected head injury?
3. How to classify severity of head injury?
4. What is the safe/effective pre-hospital/primary care assessment in head injury by healthcare provider? (e.g. GCS)
5. What are the criteria for discharge/referral in patient with head injury at primary care setting?
6. What is safe/effective pre-hospital care/primary care in head injury?
7. What are safe/effective measures to prevent secondary injury during transfer of patient with head injury to hospital?
8. What are the triage criteria for patient with head injury in ED?
9. What is safe/effective initial management of mild/moderate/severe head injury in ED?
10. What are the criteria for observation of head injury in ED?
11. In mild head injury, what is the safe/effective method, frequency and duration of observation /assessment in ED?
12. What are the criteria for admission of patient with head injury (post-observation at ED)?
13. What are the criteria for discharge of patient with head injury from ED without observation?
14. What are the indications for urgent/immediate CT head in head injury?
15. What are the indications for CT Imaging in head injury?
16. What are the criteria of skull x-ray in head injury if CT is not available?
17. What are the criteria for repeat CT in patients with head injury who do not need surgical intervention?
18. Is anaesthesia/non urgent and non-life threatening extracranial surgery safe for patient with head injury?
19. Is platelet transfusion safe/effective in patients with head injury and on preexisting anticoagulant?
20. What are the criteria for safe extubation in patient with head injury?
21. How effective is tele-consultation in management of head injury?
22. What are the indications for transfer of patients with head injury to neuro-trauma services?
23. What is safe/effective analgesia in head injury?
24. What is safe/effective sedation and reversal in head injury?
25. What are the criteria to start anticonvulsant in head injury?
26. What is the safe/effective IVD (e.g. hypertonic saline)/diuretics in head injury?
27. When and how should patient with head injury be followed-up?
28. What discharge advice should be provided to patient/care givers of head injury?

APPENDIX 3

GLASGOW COMA SCALE AND SCORE

The GCS is based on a 15 point scale used for estimating and categorising the severity of brain injury following a TBI. The scale measures the best motor, verbal and eye opening response.

Eye Response	Spontaneous eye opening	4 points
	Opens to verbal command, speech, or shout	3 points
	Opens to pain, not applied to face	2 points
	No eye opening	1 point
Verbal Response	Alert and oriented	5 points
	Confused conversation, but able to answer questions	4 points
	Inappropriate responses, jumbled phrases, but discernible words	3 points
	Incomprehensible speech	2 points
	No sounds	1 point
Motor Response	Obeys commands for movement fully	6 points
	Localizes to noxious stimuli	5 points
	Withdraws from noxious stimuli	4 points
	Abnormal flexion, decorticate posturing	3 points
	Extensor response, decerebrate posturing	2 points
	No response	1 point

Glasgow Coma Score

The score is the cumulative sum of the scale in each component. The levels of head injury severity are classified as:

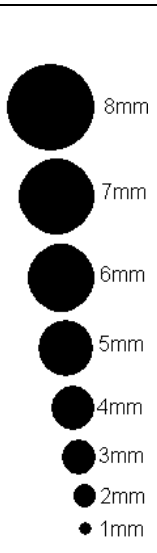
Mild	GCS 13 - 15
Moderate	GCS 9 - 12
Severe	GCS 3 - 8

APPENDIX 4

HEAD CHART

Name:_____ **Age:**_____ **Sex: Male / Female**

IC:_____ **RN:**_____ **Ward:** _____

Date																**PUPILS SCALE**
Time																
STATUS	**TEMP(+)** / **Pulse (Blue)** / **BP (Red)**	**Temp**	**Pulse**													 E EYE CLOSED DUE TO SWELLING (C) V EENDOTRACHEAL TUBE OR TRACHEOSTOMY (T) M USUALLY RECEIVED BEST ARM RESPONSE
		41	180													
		42	160													
		39	140													
		38	120													
		37	100													
		36	80													
		35	60													
		34	40													
	Pain Score															
	Respiratory Rate															
	Oxygen (L/min or %)															
	Oxygen saturation %															
	Pupils	**Right**	**Size**													
			Reaction													
		Left	**Size**													
			Reaction													
BEST COMA SCALE	E >1YR	**SPONTANEOUSLY**														E <1YR **SPONTANEOUSLY**
		TO VERBAL COMMAND														**TO VERBAL COMMAND**
		TO PAIN														**TO PAIN**
		NO RESPONSE														**NO RESPONSE**
	V >1 YR	**ORIENTED AND CONVERSES**														V <1 YR **SMILE, COOS APPROPRIATELY**
		DISORIENTED AND CONFUSED														**CRIES, CONSOLABLE**
		INAPPROPRIATE WORDS														**PERSISTENT INAPPROPRIATE CRYING OR SCREAMING**
		INCOMPREHENSIBLE SOUNDS														**GRUNTS, AGITATED, RESTLESS**
		NO RESPONSE														**NO RESPONSE**
	M >2 YR	**OBEYS COMMAND**														M <2 YR **NORMAL SPONTANEOUS MOVEMENTS**
		LOCALIZES PAIN														**LOCALIZES PAIN**
		FLEXION WITHDRAWAL														**FLEXION WITHDRAWAL**
		ABNORMAL FLEXION														**ABNORMAL FLEXION**
		EXTENSION TO PAIN														**EXTENSION TO PAIN**
		NO RESPONSE														**NO RESPONSE**
TOTAL GCS																
LIMBS MOVEMENT	**ARMS**	**NORMAL POWER**														**RECORD RIGHT (R) AND LEFT (L) SEPERATELY IF THERE IS A DIFFERENT BETWEEN THE TWO SIDES**
		MILD WEAKNESS														
		SEVERE WEAKNESS														
		SPASTIC FLEXION														
		NO RESPONSE														**CLINICAL EVENTS:**
	LEGS	**NORMAL POWER**														**vomit ≥ 2x**
		MILD WEAKNESS														**seizure**
		SEVERE WEAKNESS														**diffuse headache**
		SPASTIC FLEXION														**amnesia**
		NO RESPONSES														**abnormal behaviour**

APPENDIX 5

DISCHARGE ADVICE FORM FOR HEAD INJURY

Patients name:	Contact No:
Care givers name:	Date:
IC/RN:	

If any of the following symptoms are present immediately contact the hospital for advice.

If within the next 24 hours you experience/as observed by caregiver:-

- Fainting or sleepiness 
- Increase confusion, unable to recognize people or place 
- Change in behaviour 
- Constant headache which is worsening 
- Vomiting 
- Cannot remember new events 
- Jerking or seizures, abnormal speech 
- Bleeding or fluids coming out of the ear 
- Cannot move any part of your body 

What you should and should not do

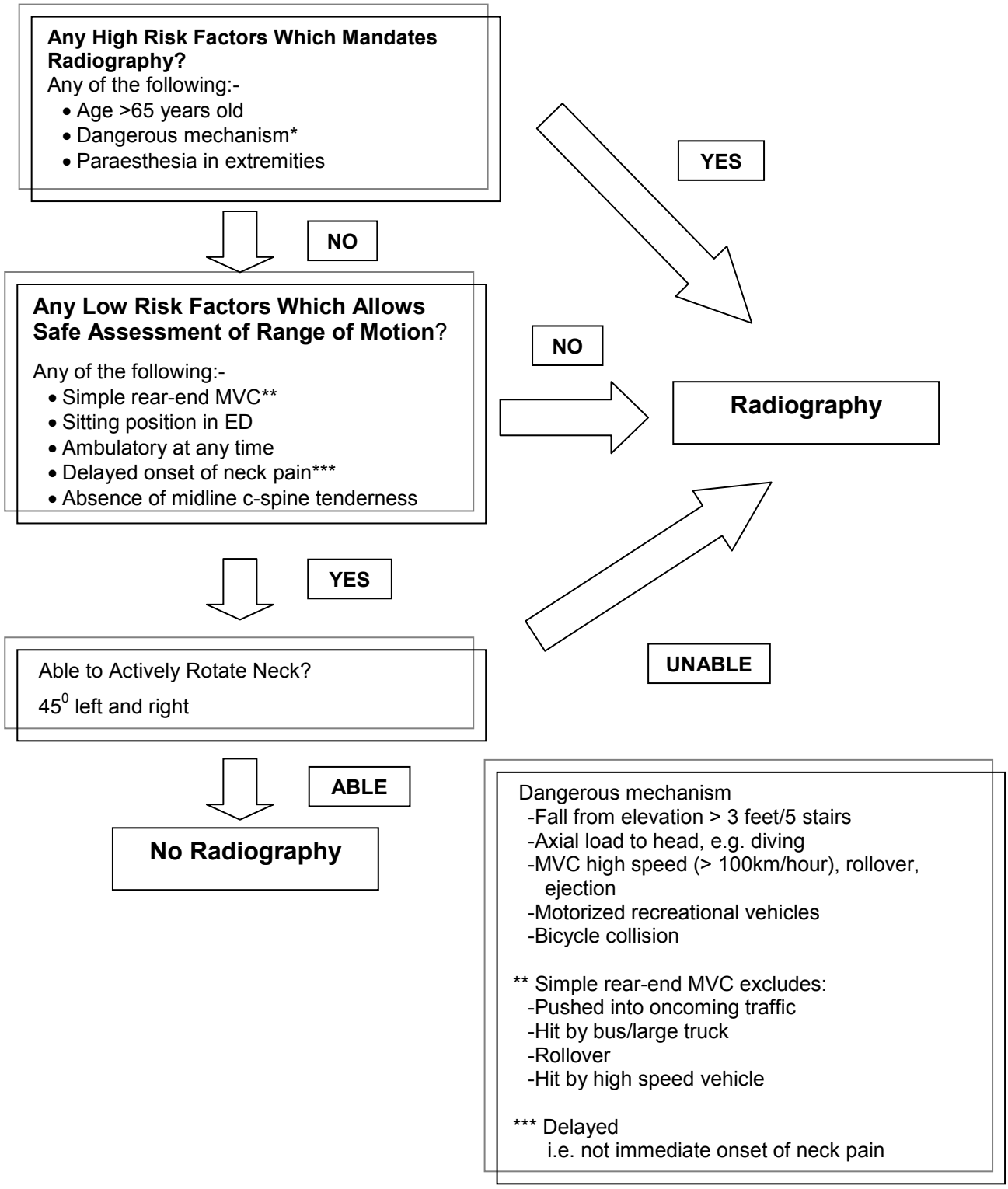
DO	DON'T
√ take paracetamol for headache	**X** take sleeping pills
√ take your usual pills	**X** take alcohol till better
√ mild exercise when you feel better	**X** play aggressive sport for a while and confirm with your doctor when you can
√ take rest or a few days off from work	**X** drive

Name Dr:
Emergency Contact:
Witness:

APPENDIX 6

CANADIAN CERVICAL RULE (CCR)

For alert (GCS=15) and stable trauma patients where cervical spine injury is concern



Source: Stiell IG, Clement CM, McKnight RD, et al. The Canadian C-spine rule versus the NEXUS low-risk criteria in patients with trauma. N Engl J Med. 2003 349(26):2510-2518.

APPENDIX 7

The NEXUS Low-Risk Criteria for Low Probability of Cervical Injury

Cervical-spine radiography is indicated for patients with trauma unless they meet all of the following criteria:-

- No posterior midline cervical-spine tenderness[a]
- No evidence of intoxication[b]
- A normal level of alertness[c]
- No focal neurologic deficit[d]
- No painful distracting injuries[e]

Criteria are from Hoffman and colleagues.

[a] Midline posterior bony cervical-spine tenderness is present if the patient reports pain on palpation of the posterior midline neck from the nuchal ridge to the prominence of the first thoracic vertebra, or if the patient evinces pain with direct palpation of any cervical spinous process.

[b] Patients should be considered intoxicated if they have either of the following: a recent history provided by the patient or an observer of intoxication or intoxicating ingestion, or evidence of intoxication on physical examination such as an odour of alcohol, slurred speech, ataxia, dysmetria, or other cerebellar findings, or any behaviour consistent with intoxication. Patients may also be considered to be intoxicated if tests of bodily secretions are positive for alcohol or drugs that affect the level of alertness.

[c] An altered level of alertness can include any of the following: a GCS score of 14 or less; disorientation to person, place, time, or events; an inability to remember three objects at five minutes; a delayed or inappropriate response to external stimuli; or other findings.

[d] A focal neurologic deficit is any focal neurologic finding on motor or sensory examination.

[e] No precise definition of a painful distracting injury is possible. This category includes any condition thought by the clinician to be producing pain sufficient to distract the patient from a second (neck) injury. Such injuries may include, but are not limited to, any long-bone fracture; a visceral injury requiring surgical consultation; a large laceration, degloving injury, or crush injury; large burns; or any other injury causing acute functional impairment. Physicians may also classify any injury as distracting if it is thought to have the potential to impair the patient's ability to appreciate other injuries.

Source: Stiell IG, Clement CM, McKnight RD, et al. The Canadian C-spine rule versus the NEXUS low-risk criteria in patients with trauma. N Engl J Med. 2003 349(26):2510-2518.

APPENDIX 8

EQUIPMENT FOR TRANSFER

A. Essential equipments:

- portable mechanical ventilator
- adequate supply of O_2
- portable battery powered multifunction monitor to include:
  - ECG
  - non-invasive BP backup
  - pulse oximetry
  - temperature (optional)
  - invasive pressure monitoring (optional)
  - capnography (optional)

B. Other equipment:

- suction
- battery powered syringe pumps
- battery powered IV volumetric pumps (infusion by gravity is unreliable during transfer)
- intubation equipment
- self-inflating bag, valve and mask
- venous access equipment
- defibrillator/AED
- spare batteries
- blanket

C. An adequate supply of essential drugs to go with the patient

- sedative agents e.g. midazolam
- muscle relaxants e.g. atracurium, vecuronium, suxamethonium may be required for re-intubation
- analgesics e.g. alfentanil, fentanyl,
- anticonvulsants e.g. diazepam, thiopentone
- mannitol 20%, frusemide
- vasoactive drugs e.g. ephedrine, dopamine, noradrenaline
- atropine
- sodium bicarbonate
- IV fluids

D. Communication Equipment

Adapted from: Ayson M. Best-evidence Review of Transfer Protocols for Moderate to Severe Traumatic Brain Injury. ACC: 2011.

APPENDIX 9

TRANSFER CHECKLIST FOR NEUROSURGICAL PATIENTS

Checklist		YES	NO
Respiration	SpO_2 >90%? Airway clear? Airway protected adequately? (where applicable) Intubation and ventilation required? (where applicable)		
Circulation	BP MAP >80 mmHg? (adults) Pulse <100/min? (adults) Continuous cardiac monitoring? Peripheral perfusion adequate? Two reliable large bore IV cannulae in situ? Estimated blood loss already replaced? Arterial line? (optional) Central venous access? (optional)		
Head injury	Admission GCS recorded? GCS before transfer recorded? Pupillary size and reactivity recorded? Focal signs recorded? Seizures controlled? Raised ICP appropriately managed?		
Others	Cervical spine injury (cervical spine protection), chest injury, fractured ribs, pneumothorax addressed? Intra-thoracic, intra-abdominal bleed addressed? Pelvic fracture addressed? Long bone injuries splinted? Continuous bladder drainage? Nasogastric tube? (where applicable) Blood available? (where applicable) Chest tube function? (where applicable)		
Escort	Appropriate personnel escorting adequately experienced and trained? Instructed about this case? Adequate equipment and drugs? Sufficient oxygen supplies? (should be additional one hour or twice the estimated journey time) Referral letter attached? CT scans/X-rays films/CD attached? Where to go in the neurosurgical unit? Telephone numbers programmed into mobile phone? Electronic and communication equipment battery fully function? Name and contact number of receiving doctor?		

The development of standardised transfer documentation is encouraged according to the local setting.

APPENDIX 10

SAFE EXTUBATION CRITERIA IN HEAD INJURY

If the patients are to be safely extubated in ED, the following criteria should be met:

No.	Criteria	YES	NO
1.	Resolution of the process necessitating intubation		
	The original airway or breathing problem has resolved		
2.	Able to oxygenate and ventilate on low ventilator settings		
	A. Options for assessing ability to oxygenate and ventilate would include oxygen saturation >92% or a normal arterial blood gas		
	B. A common assessment of respiratory strength would be negative inspiratory force (NIF) <-30cm H_2O (normal NIF values would be -90 to -120 cm H_2O)		
	C. Typical low ventilator settings would include the following:		
	• Pressure support ≤10		
	• PEEP ≤ 8		
	• Tidal volumes ≥5 mL/kg		
	• FiO2 ≤0.40		
3.	Able to maintain a patent airway		
	A. Anatomically easy airway for laryngoscopy and intubation		
	B. Patient follows commands (opens eyes, grasps hand, lifts head off bed)		
	C. A cuff leak is present: with the cuff of the endotracheal tube deflated, a leak >25% should be present (exhaled volume less than inhaled volume due to leak)		
4.	Anticipated clinical course does not require mechanical ventilation		
	A. Good cough with acceptable secretions		
	B. Haemodynamically stable, with no vasopressors		
	• SpO_2>92% on FiO2 <0.4		
	• HR <100 beats/min		
	• RR <30 breaths/min		
	• SBP >90 mmHg		
	• No active cardiac ischemia		
	C. No other mitigating factor		
	• Cervical spine injury or instability		
	• Acute lung injury		
	• Acute pharyngeal injury		
	• Plan for imminent operation or transport		
	• Attending physician feels uncomfortable with extubation		

Preferably patients should be placed in HDU or Critical Care Area.

Source: Gray SH, Ross JA, Green RS. How to safely extubate a patient in the emergency department: a user's guide to critical care. CJEM. 2013 Sep;15(5):303-6.

APPENDIX 11

DRUG DOSING REGIMEN FOR INITIAL MANAGEMENT

A. Analgesia / Sedation

Drug	Dose	Adverse Reaction (>10%)
Benzodiazepines Midazolam	**Analgesia:** 0.01 - 0.2 mg/kg/hour continuous infusion **Sedation:** IV infusion 0.05 - 0.1mg/kg over at least 2 - 5minutes	**Respiratory**: Decreased respiratory rate (23%) Apnea (13%)
Opiod Fentanyl	**Analgesia:** 0.5 - 2 mcg/kg/h continuous infusion	**Cardiovascular:** bradycardia, oedema **CNS:** CNS depression, confusion, dizziness, drowsiness, fatigue, headache, sedation **Endocrine &metabolic:** dehydration **GI**: Constipation, nausea, vomiting, xerostomia **Local:** application site reaction **Neuromuscular & skeletal**: chest wall rigidity (high dose IV), muscle rigidity, weakness **Ocular:** miosis **Respiratory:** dyspnoea, respiratory depression **Miscellaneous:** diaphoresis
Morphine Sulphate	**Analgesia :** 0.05–0.1 mg/kg/hr continuous infusion	**Cardiovascular:** bradycardia, hypotension **CNS:** drowsiness (9 - 48%), dizziness (6 - 20%) **GI:** xerostomia (78%), constipation (9 - 40%), nausea (7 - 28%)

B. Anticonvulsant

Drug	Dose	Adverse reaction
Phenytoin	**Loading dose**: 15 - 20 mg/kg intravenous infusion over 30 - 60 minutes **Maintenance dose:** IV 100 mg given three times	**IV effects:** hypotension, bradycardia, cardiac arrhythmia, cardiovascular collapse(especially with rapid IV use),venous irritation and pain **Concentration related effects :**

	daily Oral 300mg ON for a total of seven days	Nystagmus, blurred vision, diplopia, ataxia, slurred speech, dizziness, drowsiness, lethargy, coma, rash, fever, nausea, vomiting, confusion, mood changes >20mcg/mL: far lateral nystagmus >30mcg/mL: 45®lateral gaze nystagmus and ataxia >40mcg/mL: decreased mentation >100mcg/mL: death
Levetiracetam	**Loading dose:** 20 mg/kg IV (rounded to the nearest 250 mg and administered over 60 min) **Maintenance dose:** 1000 mg IV every 12 hrs (given over 15 min) The dose may be adjusted as needed for therapeutic effect up to 1500 mg every 12 hrs (3000 mg/day).	**CNS:** behavioural symptoms (agitation, aggression, anger, anxiety, apathy, depersonalization, depression, emotional lability, hostility, hyperkinesias, irritability, nervousness, neurosis, and personality disorder (5 - 13%), somnolence (8 - 23%), headache (14%), hostility (2 - 12%) **GI**: vomiting (15%)

Source from:

- Brain Trauma Foundation; American Association of Neurological Surgeons; Congress of Neurological Surgeons; Joint Section on Neurotrauma and Critical Care, AANS/CNS, Bratton SL, Chestnut RM, Ghajar J, et al. Guidelines for the management of severe traumatic brain injury. II. Hyperosmolar therapy. J Neurotrauma. 2007;24 Suppl 1:S14-20. Erratum in: J Neurotrauma. 2008 Mar;25(3):276-8.
- Flower O, Hellings S. Sedation in traumatic brain injury. Emerg Med Int. 2012;2012:637171
- Drug Information Handbook, 22th ed. Hudson, Ohio, Lexi-Comp, Inc.;2013:1143-7.

LIST OF ABBREVIATIONS

BP	Blood pressure
BPM	Beats per minute
ACOS-COT/CDC	American College of Surgeon – Committee on Trauma /Centre for Disease Control
CCR	Canadian Cervical Spine Rule
CCTHR	Canadian CT Head Rule
CI	Confidence interval
CPG	Clinical practice guidelines
CPP	Cerebral perfusion pressure
CSI	Cervical spine injury
CSF	Cerebral spinal fluid
CT	Computed tomography
DG	Development group
ECP	Emergency care providers
ED	Emergency department
EP	Emergency physician
FFP	Fresh frozen plasma
FiO_2	Fraction of inspired oxygen
GA	General anaesthesia
GCS	Glasgow Coma Score
GOS	Glasgow outcome scale
HDU	High Dependency Unit
HR	Heart rate
ICH	Intracranial haemorrhage
ICP	Intracranial cerebral pressure
ICU	Intensive care unit
INR	International normalized ratio
IPH	Intraparenchymal haemorrhage
ISS	Injury severity score
IV	Intravenous
LOC	Loss of consciousness
LR	Likehood ratio
NEXUS	National Emergency X-radiography Utilization Study
NOC	New Orleans Criteria
MAP	Mean arterial pressure
MoH	Ministry of Health
MHI	Mild head injury
MVC	motor vehicle collision
OR	Odd ratio
PCC	Prothrombin complex concentrate
PEEP	Positive end-expiratory pressure
PHC	Pre-hospital care
PTS	Post-traumatic seizure
RC	Review Committee
RCT	Randomised Control Trial
RR	Respiratory rate
SAH	Subarachnoid haemorrhage
SBP	Systolic blood pressure
SpO_2	Oxygen saturation
TBI	Traumatic brain injury
vs	versus
WAICH	Warfarin associated intracranial haemorrhage

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