Guidance for Trauma Units

Inpatient Management of Adult Traumatic Brain Injury

Produced in collaboration by

East of England Trauma Network

Cambridge University Hospitals NHS Foundation Trust

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Contents

Introduction

Who is this for?

This guideline is intended for healthcare professionals caring for adults (patients over the age of 18) with traumatic brain injury who do not require transfer to a neurosciences centre. It details assessment, ongoing monitoring, when to discuss and re-discuss with neurosurgery, and criteria for safe discharge.

All patients will have already been referred via ORION or discussed with the CUH Neurosurgical team or the Trauma Network Co-ordination Service (NCS). Please refer to TEMPO for guidance on Immediate Management of Traumatic Brain Injury. This document does not replace the NICE Guideline on Early Management of Traumatic Brain Injury and should be read in conjunction with it. This guideline is aimed at the East of England but the principals are applicable nationally and internationally.

Definitions and scope

Traumatic Brain Injury (TBI) – any damage to the brain resulting from trauma to the head. For the purposes of this guideline, TBI refers to any patients with abnormalities on brain imaging, neurological deterioration, or persistent post-traumatic amnesia requiring admission as a direct result of trauma/injury.

Locally managed – patients who require admission to a Trauma Unit for a period of observation following TBI, but who do not require transfer to a Major Trauma/neurosciences centre. Typically, these patients will have abnormalities on brain imaging which have been discussed with a neurosciences centre, and where the recommendation has been to admit the patient locally for a period of neuro-observation.

Background

Traumatic brain injury is one of the leading causes of death and disability worldwide, and each year 1.4 million people attend hospital with a head injury, of which 200,000 will require admission. While in an ideal scenario, most TBI patients would be managed in a neurosciences centre under specialist supervision, a resource-limited healthcare system means that local triage and selective transfer to tertiary neurosurgical beds is needed to ensure that TBI patients most in need of specialist care promptly receive this. Accordingly, over 80% of patients with severe TBI, defined as a Glasgow Coma Score (GCS) of 8 or less, will either be transferred or directly admitted to a neurosciences centre, however a significant cohort of TBI patients (~37%) will be managed locally, predominantly in mild TBI cases (GCS 14–15). Indeed, many of these mild TBI cases can be safety cared for in their local trauma unit with appropriate guidance and consultation from a neurosciences centre.

In light of this, it is recognised that clear guidance covering all aspects of inpatient management, criteria for discharge and follow up will be useful in supporting local ward teams in their management of TBI patients who have been discussed with a neurosciences centre and deemed to be appropriate for local management.

Contact details

For neurosurgical registrar – ring Addenbrooke's switchboard (**01223 245151**) and ask for the first on-call neurosurgical registrar. If the first on-call does not respond overnight because they are scrubbed in emergency theatre, referrers can either ring back in non-urgent cases or if the referral is urgent and/or time-critical, ask for the second on-call neurosurgical registrar (again via Addenbrooke's switchboard).

For Trauma Network Co-ordination Service (NCS) – **0300 330 3999**.

General referral information

All referrals to the neurosurgical service from regional Trauma Units should initially be made online via https://orioncloud.org. These referrals are regularly reviewed and answered by the on-call neurosurgical registrar, in or out of hours. All referrals on Orioncloud will also be reviewed by the on-call neurosurgical consultant either at the time of referral, or the next morning before 8am. For patients requiring transfer, the speed of transfer will be specified by the on-call neurosurgical registrar at the time of referral but any clinical or neurological deterioration following this should warrant prompt re-discussion with the neurosurgical service.

In urgent or emergency cases, Orioncloud referrals should also be followed up by contacting the on-call neurosurgical registrar via Addenbrooke's switchboard as above. The neurosurgical service can receive in excess of 50 Orioncloud referrals in a 24 hour period, alongside numerous other calls for advice from other specialties. This system has thus been designed to ensure that referrers receive timely advice whilst maintaining a written record of referrals and the advice given.

EPIC secure chat

EPIC secure chat has been rolled out across Cambridge University Hospitals and has replaced non-emergency bleeps as the preferred method of internal communication within the trust. This new service does not change the referral process for regional trauma units detailed above (ring Addenbrooke's switchboard and ask to be put through to the on-call neurosurgical registrar). Switchboard may then either forward details of the referral to the neurosurgical registrar via EPIC secure chat, or call their mobile directly. If the first on-call registrar does not respond (for example because they are operating overnight), and the referral is urgent and/or time-critical, referrers should ask switchboard for the second on-call registrar.

Summary

1. All patients admitted with TBI should have the following minimum observations undertaken regularly (as described on page 7) by a healthcare professional trained in assessing neurological status:
   - Glasgow Coma Scale, pupil size and reaction to light, limb power
   - heart rate, respiratory rate, blood pressure, temperature and oxygen saturations.

2. The following should trigger a prompt medical review, consideration of repeat CT imaging of the brain and re-discussion with Neurosurgery:
   - any sustained deterioration in GCS score of 2 or more points
   - any sustained deterioration in GCS *motor* score of 1 or more points
     – 'sustained' deterioration generally refers to 30 minutes or more
   - any new or progressive limb weakness or pupil asymmetry/unreactivity
   - any sign of raised intracranial pressure such as bradycardia or hypertension
   - any new or progressive headaches, nausea/vomiting, seizures, confusion, agitation or behaviour change.

3. Most patients admitted with TBI should have a full panel of admission blood tests, and any clotting abnormalities should warrant prompt discussion with a Haematologist. Once admitted, TBI patients should have their electrolytes checked at least 48-hourly, with a particular focus on serum sodium monitoring.

4. In general, TBI patients with clinically significant abnormalities on brain imaging will need to temporarily stop or reverse their anti-coagulation and/or anti-platelet therapy on admission, particularly when their scans show evidence of active acute bleeding. When to restart anti-coagulation/anti-platelet therapy should be a case-by-case decision, taking into the account the indications and potential risks of restarting therapy.

5. In patients admitted with TBI, mechanical thromboprophylaxis should be used to prevent venous thromboembolism. Early consideration of prophylactic low-molecular weight heparin should also occur, particularly where these patients are immobile or have had their anti-platelet/anti-coagulant therapy temporarily stopped or reversed, and their brain imaging shows only minor abnormalities. In the majority of patients, prophylactic chemothromboprophylaxis can be started at 72 hours following injury.

6. Do not discharge patients with TBI where there is evidence of post-traumatic amnesia until of the following have been undertaken:
   - they have returned to their baseline GCS, which in most cases will be 15/15;
   - their serum electrolytes have returned to their usual base line;
   - where applicable, a plan for restarting their anti-platelet/anti-coagulant therapy has been finalised.

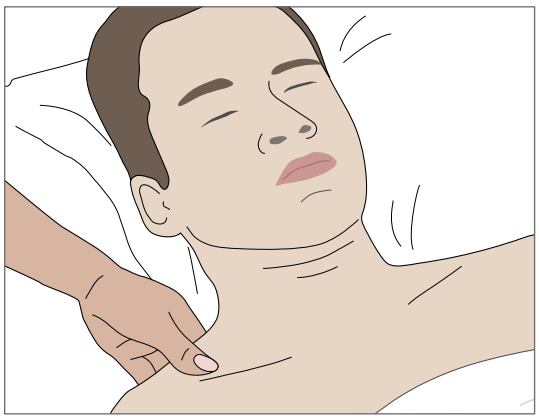
Observations

1. All neurological observations should be undertaken by a healthcare professional trained in recognising and assessing neurological status.

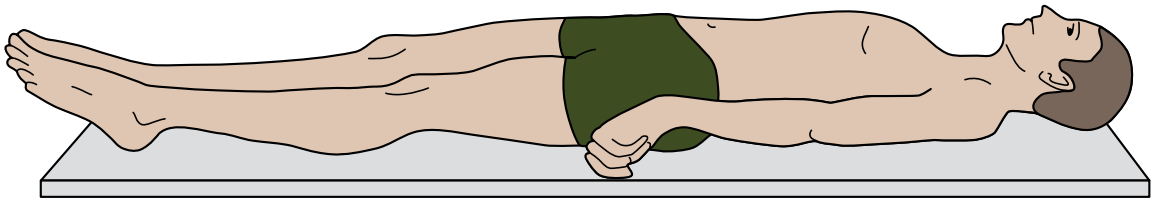
2. All patients admitted with TBI should have the following minimum observations:
   - Glasgow Coma Scale
   - pupil size and reaction to light
   - limb power
   - heart rate, respiratory rate, blood pressure, temperature and oxygen saturations.

3. The three specific neuro-observations should be assessed as follows (see Appendix 1):
   - Glasgow Coma Scale should be assessed out of 15 as follows:
     - eye opening (1–4): none, pain, speech, voice
     - verbal score (1–5): none, incomprehensible sounds, incomprehensible words, confused, orientated
     - motor score (1–6): none, extension to pain, abnormal flexion to pain, normal flexion to pain, localising to pain, obeying commands.
   - Pupil size and reactivity for both pupils:
     - record pupil diameter and it's reaction a light stimulus in millimeters, for both eyes independently
     - causes for concern are unequal, sluggishly reactive or non-reactive pupils.
   - Limb power for all four limbs – ask patient to 'pull me towards you' or 'push me away':
     - 0: no contraction
     - 1: flicker of contraction
     - 2: active movement with gravity eliminated
     - 3: active movement against gravity
     - 4: active movement against resistance
     - 5: normal power.

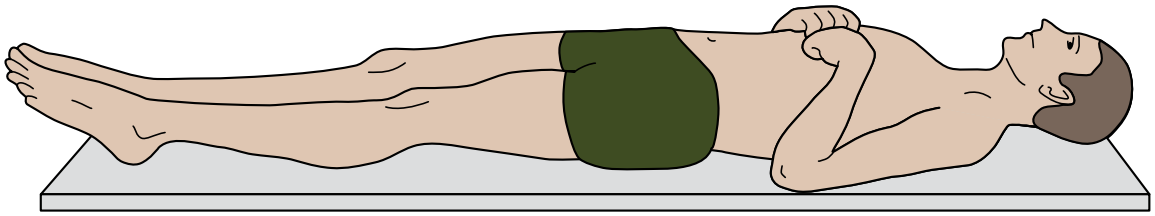
4. GCS assessment consists of three domains which must be assessed and documented separately.
   - Examples of reliable painful stimuli when assessing GCS are a trapezius squeeze between the thumb and index finger lasting no more than 30 seconds, or supra-orbital pressure: https://www.glasgowcomascale.org/#video.



- Record the **best eye opening response**:
  - **E1:** no eye opening in response to verbal or painful stimuli
  - **E2:** eye opening to painful stimulus only
  - **E3:** eye opening to verbal stimulus
  - **E4:** eye opening spontaneously with no verbal or painful stimulus needed.
- Record the **best verbal response**:
  - **V1:** non-verbal
  - **V2:** incomprehensible sounds without recognizable words, for example moaning or groaning
  - **V3:** inappropriate words including dysphasia, for example shouting or swearing without being able to sustain a conversation
  - **V4:** confused where speech is conversational but the patient is disorientated
  - **V5:** orientated with awareness of time, place, person.
- Record the **best motor response**:
  - **M1:** no response to any stimulus
  - **M2:** extension to pain – internal rotation and adduction of the shoulder with elbow and wrist extension in response to trapezius squeeze/supra-orbital pressure:



  - **M3:** abnormal flexion to pain – elbow and wrist flexion towards the body in response to a trapezius squeeze/supra-orbital pressure (slow):



  - **M4:** normal flexion to pain – arm is lifted with forearm flexed but below the clavicle in response to a trapezius squeeze/supra-orbital pressure (brisk) Trauma Unit Management of Traumatic Brain Injury 7
  - **M5:** localising to pain – arm is lifted above the clavicle towards the trapezius squeeze/ supra-orbital pressure stimulus
  - **M6:** obeys commands – such as squeezing fingers or raising arms.

5. Note that some patients will have a pre-TBI baseline GCS which is not necessarily 15 (e.g. dementia patients, learning disability patients, those with neurological disorders).

6. GCS score should be communicated to other healthcare professionals using a verbal description, for example 'eye opening to voice, confused and localising to pain' instead of 'GCS 12'. If the numerical components of GCS are used, they must be broken down into the individual components, i.e. E3V4M5.

7. Neuro-observations should be repeated every 30 minutes until and unless the patient is GCS 15.

8. In patients who are GCS 15, neuro-observations should be repeated half-hourly for 2 hours, then hourly for 4 hours, then 2-hourly. If patients drop their GCS from 15, neuro-observations should revert to half-hourly until they regain a GCS of 15.

9. The following symptoms should be monitored
   - headache intensity (0–10), where 0 = no pain, and 10 = worst pain
   - nausea and/or vomiting
   - seizure
   - agitation / abnormal behaviour.

10. The following should trigger a prompt medical review:
    - any sustained deterioration in GCS score of 2 or more points
    - any sustained deterioration in GCS *motor* score of 1 or more points
      - 'sustained' deterioration for the purposes of this guideline generally refers to 30 minutes or more
    - any new or progressive limb weakness or pupil asymmetry/unreactivity
    - any sign of raised intracranial pressure such as bradycardia or hypertension
    - any new or progressive headaches, nausea/vomiting, seizures, confusion, agitation or behaviour change.

Blood tests

1. The majority of patients admitted with TBI should have a full set of baseline admission blood tests including a full blood count, liver function tests, clotting profile, renal function tests and electrolytes.

   Any admission clotting abnormalities should warrant discussion with Haematology for possible correction, particularly in cases with a large blood load on admission CT imaging.

2. Once admitted all TBI patients should have strict fluid balance monitoring, and their electrolytes should be checked at least every 48 hours. Sodium abnormalities are the most common electrolyte disturbance following TBI, usually secondary to hypothalamic-pituitary axis dysfunction.

   This can manifest as syndrome of inappropriate anti-diuretic hormone secretion (SIADH) causing dilutional hyponatraemia, cerebral salt wasting (CSW) causing hyponatraemia secondary to natriuresis, or diabetes insipidus (DI) causing hypernatraemia.

   In all cases, any abnormality in serum sodium should prompt a clinical assessment of the patient and their fluid balance, as well as assay of paired serum and urinary osmolarities, and a urinary sodium measurement (see Table 1).

   i. SIADH presents with euvolaemic hyponatraemia, low serum osmolarity with an inappropriately high urine osmolarity and urine sodium over 20mmol/L. Fluid balance tends to be positive

   ii. CSW presents with hypovolaemic hyponatraemia, low serum osmolarity, high urine osmolarity and urine sodium well over 20mmol/L (usually much higher than in SIADH). Fluid balance tends to be negativ

   iii. DI presents with hypovolaemic hypernatraemia, high serum osmolarity with an inappropriately low urine osmolarity, and polyuria with a negative fluid balance.

	Serum Na	Serum Osm	Urine Osm	Urine Na	Fluid status and balance
SIADH	Low	Low	High	>20	Euvolaemic/Hypervolaemic positive balance
CSW	Low	Low	High	>>20	Hypovolaemic negative balance
DI	High	High	Low	Variable	Hypovolaemic negative balance

Table 1: Summary of key biochemistry and fluid balance findings in the three most common sodium abnormalities seen in TBI patients.

If the serum sodium falls below 130mmol/L or is falling rapidly, paired osmolarities, fluid balance and urinary sodium should be discussed with an Endocrinologist in order to clarify the underlying diagnosis and guide treatment.

i. Patients with confirmed SIADH should usually be managed with fluid restriction in liaison with an Endocrinologist, if there are no contra-indications to this. Severe cases may require intravenous salt replacement, usually given in an intensive care setting.

ii. Patients with confirmed CSW should usually be managed with salt and fluid replacement, or fludrocortisone, in liaison with an Endocrinologist and if there are no contra-indications to this. Severe cases may require intravenous salt replacement, usually given in an intensive care setting.

iii. Patients with confirmed DI secondary to TBI should usually be managed with fluid replacement in liaison with an Endocrinologist, if there are no contra-indications to this. Severe cases may require desmopressin.

iv. Patients with severe hyponatraema (i.e. <125mmol/L) typically require management in an HDU environment. This permits arterial line monitoring and 4-hourly blood sampling until the serum sodium has normalised.

3. Serum potassium derangements are the second most common electrolyte disturbance in TBI patients and hence these levels should also be checked at least every 48 hours.

- Hypokalaemia is less well understood but could be due to urinary loss secondary to a large catecholamine discharge that is known to accompany head trauma, which results in beta-2-adrenergic stimulation of sodium-potassium pumps both in cells and in the kidney, both of which can deplete intravascular potassium. Injudicious use of intravenous fluids without sufficient potassium replacement is an iatrogenic cause. This is usually managed with oral or intravenous replacement.
- Hyperkalaemia can also occur, potentially secondary to systemic cell damage, and should be managed as per local guidelines.

4. Serum calcium, magnesium and phosphate disturbances can also occur in severe TBI cases, although these are unlikely to be managed locally and routine monitoring of these electrolytes is unlikely to be required in locally managed cases, unless there are concerns about re-feeding.

Medication management

1. In general, patients managed locally with TBI should have their usual medications prescribed during their admission, with the following exceptions:
   - anti-coagulants and anti-platelets (see points 2–4)
   - medications which can exacerbate potential serum electrolyte abnormalities, such as diuretics.
     – These should be considered on a case-by-case basis taking into the account the indications for these medications and the likely adverse effects of temporarily stopping them.
   - medications which can lower seizure threshold, such as Ciprofloxacin, where alternatives are available.

2. Intracranial haemorrhage is a critical site for bleeding which requires emergency or urgent reversal of anticoagulation. In general, TBI patients with clinically significant abnormalities on brain imaging will need to temporarily stop or reverse their anti-coagulation and/or anti-platelet therapy on admission, particularly when their scans show evidence of active acute bleeding. There are no standardised guidelines pertaining to this, and decisions need to be made on a case-by-case basis in liaison with Neurosurgery, Haematology and Cardiology if applicable.
   - Warfarin should be reversed in liaison with the local Haematologist. The target INR for reversal should generally be less than 1.4.
   - Novel oral anti-coagulants (NOACs) and anti-platelets should also be discussed with the local Haematologist, as some degree of reversal may still be possible.
   - Reversal decisions should take into account the indication for the anti-coagulant and anti-platelet therapy. For example, patients on anti-platelets due to cardiac stents, or Warfarin due to mechanical aortic valves are at higher risk of thrombo-embolic complications and hence reversal decisions can be finely balanced in the presence of only minor bleeds on CT imaging of the brain.

3. When to restart anti-coagulation/anti-platelet therapy should be a case-by-case decision, taking into the account the indications and potential risks of restarting therapy.
   - In patients taking anti-platelets for primary prevention, or Warfarin/NOACs for AF without previous strokes, a broadly acceptable time frame in which to restart therapy following TBI with abnormalities on brain imaging is 2–4 weeks. The risks of re-starting anticoagulation must be made clear to the patient.
   - In patients taking anti-platelets for secondary prevention, cardiac stents, intracranial stents, or in patients taking Warfarin for mechanical valves or recurrent venous thrombo-embolism, earlier restarting of therapy may be indicated on a case-by-case basis in liaison with Neurosurgery, Haematology and Cardiology if applicable.

4. Where possible, patients should be counselled about the risks versus benefits of stopping, reversing and restarting their anti-platelet or anti-coagulant therapy, and be fully informed in the decision-making process. There is no risk free option in many circumstances and this should be communicated to the patient and their next of kin.

5. In patients admitted with TBI, mechanical thromboprophylaxis (TEDs and IPCs) should be used to prevent venous thromboembolism.

6. Early consideration of prophylactic low-molecular weight heparin should occur, particularly where these patients are immobile or have had their anti-platelet/anti-coagulant therapy temporarily stopped or reversed, and their brain imaging shows only minor abnormalities. In the majority of patients, prophylactic chemothromboprophylaxis can be started at 72 hours following injury, with the following caveats:

   - in the absence of haemorrhagic lesions on CT imaging, earlier commencement of prophylactic chemothromboprophylaxis may be warranted
   - however, in the presence of a large blood load/contusions, chemothromboprophylaxis may need to be delayed, and these cases should be discussed with the neurosurgical servic.

7. Prophylactic anti-epileptic drugs (AEDs) to prevent early post-traumatic seizures may be advised in certain cases. This should be discussed with the neurosurgical service at the time of initial referral.

8. Patients who develop seizures following TBI should be treated with AEDs in accordance with local guidelines and in consultation with a Neurologist or Epilepsy specialist.

   - Seizures at the time of impact do not have the same prognostic importance for ongoing seizure risk as compared to seizure activity developing later in the patient course. In patients with clinical or electrographic evidence of seizure activity >24 hours following TBI or during their hospital admission, AEDs are likely to be continued beyond discharge, in consultation with a Neurologist or Epilepsy specialist. These patients should be referred to a neurotrauma clinic on discharge.

9. In patients with penetrating brain injuries or open skull fractures, a seven day course of prophylactic Co-Amoxiclav should be given if there are no contra-indications to this. In most cases, these patients will also require transfer to a neurosurgical centre.

10. In patients with a penetrating brain injury, base of skull fracture, CSF leak or pneumocephalus on brain imaging following TBI, pneumovax vaccination should be administered.

11. Do not practice permissive hypotension in patients with TBI, as maintenance of normotension is critical in preventing secondary brain injury.

    - In ward-managed patients, the intravenous fluid of choice for resuscitation and maintenance of blood pressure is 0.9% normal saline. The higher osmolarity of 0.9% normal saline is preferable to Hartmann's.
    - Do not use dextrose for intravenous fluid resuscitation or maintenance, as it can increase cerebral oedema by reducing serum osmolality.

Critical Care and perioperative management

1. Patients requiring neuro-critical care, intracranial pressure monitoring and/or potential surgery due to their TBI will be looked after in a neurosciences centre. This section covers TBI patients requiring critical care or non-neurosurgical operations for reasons other than their TBI, such as in the context of polytrauma and the trauma patient requiring orthopaedic or general surgical procedures.

2. The following parameters should be maintained in critical care patients with TBI, or those requiring non-neurosurgical operations under general anaesthesia:
   - head up 30 degrees where spinal precautions allow
   - PCO_2 should be kept between 4.5–5.5kPa utilising a full mandatory ventilation strategy, endotracheal tube secured airway (not supraglottic LMA), and minute volume titrated to tight CO_2 control
   - hypotension should be avoided and MAP maintained > 70mmHg using vasopressors and fluid resuscitation as needed
   - hypertension can be a physiological response to brainstem ischaemia and should not be aggressively managed in the acute setting – aim for systolic BP <200mmHg. If the cause of hypertension is not neurological deterioration, this should be treated in line with the primary cause
   - hypoxia should be avoided and oxygen saturations maintained > 97%
   - normothermia with core body temp < 37.5 degrees
   - hyper- and hypo-glycaemia should be avoided and BM controlled between 4–10
   - patients requiring spinal precautions and/or collars for suspected unstable spinal injury are likely to be transferred to a neurosciences centre.

3. TBI patients who are intubated and ventilated on critical care should have their pupillary diameter and reaction checked at least hourly to allow ongoing neurological assessment. These patients should also have a sedation hold and assessment of their GCS and any focal limb deficits at least every 6 hours for the first 48 hours, and daily thereafter.
   - Any new pupillary asymmetry or loss of light reflex should trigger an urgent clinical review, CT Head, and re-discussion with neurosurgery.
   - Similarly, any drop in GCS during sedation hold, or new limb deficits should trigger an urgent clinical review, CT Head, and re-discussion with neurosurgery.

4. Non-emergency non-neurosurgical procedures should be delayed for at least 24 hours to allow TBI patients to have an initial period of neurological observation prior to potentially prolonged general anaesthesia. This is because TBI patients can often deteriorate within the first 24 hours following their brain injury, and prolonged general anaesthesia within this crucial timeframe in the absence of intracranial pressure monitoring may result in unrecognised cerebral hypoperfusion or expansion of haematomas resulting in preventable neurological insult.

5. A repeat CT Head should be considered prior to subjecting TBI patients to prolonged general anaesthesia for non-neurosurgical procedures to confirm that their abnormalities on brain imaging are stable and not progressing.

6. TBI patients who display signs of acutely raised intracranial pressure (i.e. a fixed and dilated pupil) can be given 3–5% NaCl (hypertonic saline, HTS) via a large bore cannula in 100–200ml boluses, with ABG monitoring.
    - HTS acts as an effective volume expander and can improve haemodynamic stability as well as reduce ICP.
    - HTS dose-effect can be easily monitored via serial ABGs and incremental boluses can be repeated until serum sodium reaches 155.
    - HTS should be preferred to mannitol in the context of trauma as the powerful diuretic effects of mannitol can exacerbate hypovolaemia, electrolyte imbalance and hypotension in already unstable patients.
    - Mannitol can still be considered an option in patients with a history of chronic hyponatraemia – although aggressive osmotherapy in these patients poses a risk of myelinolysis irrespective of whether the osmotic shift is driven by sodium or mannitol.
    - Should osmotherapy fail, hyperventilation for 3–5 minutes can be used as a last resort for patients in extremis as a bridge to definitive care, such as those with a fixed and dilated pupil due to a haematoma pending surgical evacuation.
    - These patients will always require re-discussion with neurosurgery.
7. Prevention of venous thromboembolism is of particular importance in ventilated patients with TBI. All these patients should have mechanical thromboprophylaxis (TEDs and IPCs) applied on admission. Prophylactic low molecular weight heparin should also be considered early (within 72 hours of admission in most cases) once interval CT imaging has excluded active intracranial bleeding and demonstrated stable appearances of haemorrhagic contusions 24–48 hours after injury. In the presence of large haemorrhagic contusions and heavy intracranial blood load, the timing of pharmacological thromboprophylaxis should be discussed with the neurosurgical service.

Managing agitation

1. Agitation in TBI patients is very common. Consider the wide differential diagnosis before attributing agitation in TBI patients as solely secondary to their underlying brain injury:
   - neurological: seizure activity
   - medical: infection, pain, withdrawal from alcohol or drugs
   - psychiatric: psychosis, mood and anxiety disorders
   - medications: opiates, hypnotics, typical antipsychotics, anticonvulsants (especially Levetiracetam / Keppra®).

2. Drug treatment of agitation after TBI is common. There is limited evidence to guide drug treatment choice and guidelines are based on consensus and some common principles. Before starting drug treatment for agitation, always ask:
   - Is the diagnosis correct?
   - Is the treatment being used properly?
   - Is the dose effective?
   - Are there any side effects?
   - Is it best to wait and see?

3. Some common principles when initiating drug treatment for agitation:
   - start slow, go slow but go
   - add one drug at a time
   - avoid combinations
   - if it does not work after a trial, stop it
   - when possible choose drugs that are less likely to lower seizure threshold
   - avoid typical antipsychotics and/or benzodiazepines as they may delay recovery and impair neuroplasticity
   - atypical antipsychotics are as effective as haloperidol.

4. First line medications for agitation in TBI patients are:
   - IM or PO Olanzapine 2.5mg BD. 5mg QDS Maximum
   - PO Quetiapine 25 to 50mg BD, titrated according to the response and increase every 12 hours. Usual dose is 200–400mg daily in divided doses
   - benzodiazepines can cause a reduction in conscious state and should therefore be avoided or used with extreme care in those who require neurological observation.

5. Second line medications for agitation in TBI patients are:
    - Sodium Valproate 250mg BD up to 750mg BD.

6. Alcohol withdrawal is a common cause for agitation in TBI patients. This should be treated in accordance with local guidelines, usually with chlordiazepoxide.

7. Non-pharmacological methods to help prevent or treat agitation in TBI patients should also be pursued. Efforts should be made to modify the environment within a busy ward to provide TBI patients with:
    - ideally a side room
    - minimum noise
    - low lighting
    - no TV
    - minimum touch and interference
    - minimum people (max 2 visitors at a time)
    - familiar objects around
    - clock/orientation charts or equipment
    - routine feeding and feeding assessments
    - avoiding procedures and ward rounds at odd times
    - encourage sleep wake cycle
    - familiar and consistent staff taking care of the patient.

The deteriorating patient: when to re-scan and re-discuss with neurosurgery

1. Repeat CT imaging of the brain within 1 hour should be considered in patients with:
   - any sustained deterioration in GCS score of 2 or more points
   - any sustained deterioration in GCS motor score of 1 or more points
     - 'sustained' deterioration for the purposes of this guide generally refers to 30 minutes or more
   - any new or progressive limb weakness or pupil asymmetry/unreactivity
   - any sign of raised intracranial pressure such as bradycardia or hypertension
   - any new or progressive headaches, nausea/vomiting, seizures, confusion, agitation or behaviour change
   - an unexplained persistently low GCS score after initial resuscitation and observation.
2. Generally, patients who fulfill the criteria set out in point 1 will also require re-discussion with neurosurgery after repeat imaging has been obtained.
3. Consider epileptic seizure as a cause of rapid onset neurological deterioration, with a post-ictal deficit that subsequently resolves.
4. Other criteria for re-discussion with Neurosurgery are:
   - patients with new intracranial abnormalities on repeat imaging which have not previously been discussed with Neurosurgery
   - patients who develop CSF leak or other signs of basal skull fracture during their admission.
5. If the CT scan shows no new changes to account for the features in point 1 and there are ongoing clinical concerns, the patient should be re-discussed with the neurosurgical service.
6. Planned repeat CT imaging can also help to guide decision making around restarting anti-platelet/anti-coagulant therapy. For example, the absence of further acute bleeding may be re-assuring prior to restarting anti-platelets/anti-coagulants.

Criteria for discharge/follow-up

1. Do not discharge patients with TBI until they have returned to their baseline GCS, which in most cases will be 15, their serum electrolytes have returned to their usual baseline, and where applicable a plan for restarting their anti-platelet/anti-coagulant therapy has been finalised.

2. Do not discharge patients with TBI home unless they have someone available at home to supervise them for 48 hours post-discharge, except for in cases where the risk of late complications from TBI is deemed negligible.

3. Do not discharge patients with TBI from hospital until they have been assessed by a multi-disciplinary team which should include at a minimum occupational therapists and physiotherapists, and where indicated also neuropsychologists. Members of the multi-disciplinary team should be particularly vigilant for signs of post-traumatic amnesia (PTA) and post-concussion syndrome.
   - www.headway.org.uk/about-brain-injury/individuals/effects-of-brain-injury/post-traumatic-amnesia
   - www.headway.org.uk/about-brain-injury/individuals/types-of-brain-injury/mild-head-injury-and-concussion/#PostConcussionSyndrome

4. Do not discharge patients who are in post-traumatic amnesia (PTA). Patients who remain in persistent PTA will likely require specialist neuro-rehabilitation as guided by the MDT.

5. East of England Trauma Network 'Referral Guidelines to Rehabilitation Services' document can support rehabilitation decisions.

6. Patients who are agitated and want to leave the hospital should have a mental capacity assessment by an appropriate professional keeping in view the extent of the head injury and presence or absence of PTA. Appropriate legal frameworks should be applied to decision making if patients lack capacity.

7. All patients should be provided with verbal and written discharge information pertaining to their TBI which should include details of the severity of their injury, details on the likely recovery process, information on when it is safe to return to everyday activities and work, as well as safety net instructions on when to return to hospital. This discharge pack should include details on the risks of developing post-concussion syndrome, and where to seek support should patients develop this.
   - All TBI patients should be signposted to the Headway website, which has a wealth of practical information and support for TBI patients www.headway.org.uk.
   - All mild TBI cases should be provided with the following discharge factsheet www.headway.org.uk/media/2767/minor-head-injury-discharge-advice.pdf.

8. All patients with a serious head injury who drive must cease driving and inform the DVLA of their head injury as soon as practically possible. This is a legal requirement and should be conveyed to patients on discharge in both a verbal and written format.
   - As a general rule, for those with a CT abnormality, Group 1 licence holders will be considered for relicensing after 6 months depending on the severity of their injury and other clinical factors such as seizure activity and the presence of PTA. However, this is only a guide and all decisions are made on an individual basis.

- Those with post-traumatic seizures must typically stop driving until they are 1 year seizure-free.
- Professional Group 2 licence holders have a stricter set of criteria which must be met before relicencing can be considered. Expert advice is required.
- Useful links concerning neurological disorders and fitness to drive can be found on the gov.uk website:
  www.gov.uk/guidance/neurological-disorders-assessing-fitness-to-drive
  www.gov.uk/head-injury-and-driving.

9. TBI patients may be ready to return to work after a degree of recovery and should be encouraged to discuss this directly with their employer. Whilst there is no legal requirement for TBI patients to disclose details of their brain injury to their employer, this may be beneficial as employers have a legal duty to make reasonable workplace adjustments for returning workers under the Equality Act of 2010.

10. Ensure patients and their carers are aware of the possibility of delayed or persistent neurocognitive symptoms following discharge from hospital after TBI, and signpost them to community or specialist rehabilitation services in case these are required. If patients have ongoing symptoms at 6 weeks following discharge, they should be referred to a neurotrauma clinic (see below).

11. All TBI patients with clinically significant abnormalities on their brain imaging should be followed up soon after discharge in the outpatient clinic by a specialist trained in the recognition and management of delayed complications from TBI, such as a neurologist, neuropsychologist, neurosurgeon (see below), or rehabilitation medicine specialist.

12. Patients requiring follow up in the Addenbrooke's Neurotrauma clinic should be referred via email to the Addenbrooke's Neurotrauma Clinical Nurse Specialists attaching a copy of the discharge summary (cuh.neurotraumaspecialistnursescuh@nhs.net). Referrals under this pathway will be triaged and followed up in the appropriate nurse or consultant led clinic.

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Appendix 1. Example neuro-observations chart

Name:																														**Date**
Hospital number:																														**Time**
GLASGOW COMA SCALE	**Best** Eye opening	Spontaneously	4																											Eyes closed by swelling = C
		To speech	3																											
		To pain	2																											
		None	1																											
	Best Verbal response	Orientated	5																											Tracheostomy = T
		Confused	4																											
		Inappropriate words	3																											
		Incomprehensible sounds	2																											
		Silent	1																											
	Best Motor response	Obeys commands	6																											Record the best arm response
		Localises pain	5																											
		Flexion withdrawal	4																											
		Abnormal flexion	3																											
		Extension	2																											
		No Response	1																											
		TOTAL																												

PUPILS	Right	Size (mm)																												+ Reactive
		Reaction																												
	Left	Size (mm)																												- Non-reactive
		Reaction																												

LIMB POWER	Arms	Normal power	5																											If there is a laterality difference, record Right (R) and Left (L) separately
		Movement against resistance	4																											
		Movement against gravity	3																											
		Movement with gravity eliminated	2																											
		Flicker of contraction	1																											
		No response	0																											
	Legs	Normal power	5																											
		Movement against resistance	4																											
		Movement against gravity	3																											
		Movement with gravity eliminated	2																											
		Flicker of contraction	1																											
		No response	0																											