All Wales Guidelines for the Management of Devastating Brain Injury 2017

Aims and Scope:

These guidelines are intended to reduce variation in clinical practice across Wales in the management of "Devastating Brain Injury" (DBI). They should be read in conjunction with the Faculty of Intensive Care Medicine's guidance on DBI but expand on these to give clinicians in Wales practical advice and suggested clinical pathways.

Clinical evidence in this area, although rapidly developing, is still incomplete and these guidelines are intended to foster best practice based on current evidence and expert opinion as of Spring 2017. They are also intended to provide a framework for clear and realistic communication with patients' representatives.

Whilst the Welsh Intensive Care Society (WICS) and the Critical Care Implementation Group (CCIG) endorse these guidelines it must be stressed that they are only guidelines. The final responsibility for the appropriate care of any patient lies with the clinical team involved in their care.

The guidelines also do not in any way change any existing admission policies for Critical Care or Tertiary specialties.

DBI is defined in the literature as:

"Any neurological condition that is assessed at the time of hospital admission as an immediate threat to life OR incompatible with good functional recovery AND where early limitation or withdrawal of therapy is being considered." (1)

Note: In practice "limitation or withdrawal of therapy is being considered" is a key difference between Severe Brain Injury and DBI.

Causes of DBI include: (1)

- Traumatic Brain Injury (focal / diffuse)
- Ischaemic Cerebrovascular Accident
- Intracerebral Haemorrhage

- Aneurysmal Sub Arachnoid Haemorrhage
- Diffuse Hypoxic Brain Injury (e.g. asphyxiation / near drowning)

Note: Devastating Brain Injury may also be caused by inadequate cerebral perfusion during cardiopulmonary resuscitation. The care of patients following cardiac arrest is specifically excluded from this document as both International (2) and local guidance already exists for this condition.

Due to the nature and severity of their condition, patients with DBI will be unable to make decisions regarding their treatment. Treatment decisions must therefore always be made in "Best interests" as set out by the Mental Capacity Act (2005). Shared decision making between medical professionals and the patient's representatives is essential whenever possible.

Key Principles:

1. Based on current evidence it is not possible to reliably predict outcome based only on neurological / radiological features at the time of presentation.
2. Patients in poor pre-existing health or with poor functional status in whom Critical Care treatments are unlikely to confer benefit should receive treatment prioritising comfort and dignity.
3. Patients who may be candidates for tertiary treatment should be referred urgently and transferred if there is potential benefit.
4. Patients without indications for tertiary treatment should receive physiological support ("basic neurocritical care") at their closest critical care unit until their prognosis is ascertained.
5. An improvement in a patient's clinical condition is an indication for re-evaluation of the potential benefits of tertiary transfer.
6. With the exception of confirmed Brain Stem Death, withdrawal of life sustaining therapy based on poor neurological status should not be undertaken until at least 72 hours post injury.
7. The onset of multiple organ failure increases the certainty around futility of care and may be an indication for treatment limitation or withdrawal of life sustaining therapies earlier than 72 hours.
8. The majority of patients with DBI do not survive and can be expected to transition to end of life care.
9. End of life care may be provided in any clinical location (Emergency Department, Critical Care Unit, ward or theatre suite) as long as the care is of good quality. Local guidelines should set out how this care is provided.
10. Consideration of organ donation should be a routine part of end of life care. The local guidance on end of life care should include the conduct of organ donation.

Clinical Pathway:

The following pathway is recommended for the initial management of patients with DBI.

1. **Transport:**
   In the absence of known contra-indication, the patient should be stabilised by appropriate resuscitative measures and transported urgently to a medical facility with appropriate clinical and diagnostic facilities. This is usually the closest Emergency Department (ED).

2. **Stabilisation:**
   Upon arrival at the ED, if not contra-indicated or already performed, the patient should be intubated for airway protection, placed on mechanical ventilation and have initial cardiovascular system stabilisation.

   Note: Failure to stabilise a patient's condition represents a failure of treatment and should prompt transition to end of life care.

3. **Diagnosis:**
   Following resuscitation a diagnosis should be made as quickly as possible. This will be based on the history, physical examination and appropriate imaging – usually Computerised Tomography (CT) scanning. Occasionally other imaging modalities (e.g. CT venogram or angiography) may be required.

4. **Assessment and Plan:**
   Senior (consultant) input from all relevant specialties (including colleagues in tertiary specialties) should be collated to decide on an appropriate treatment plan. The patient's pre-existing health and functional status, as well as any previously expressed wishes, must be considered at this stage. If time allows, any proposed treatments (or treatment limitation) should be discussed with the patient's representatives.

5. **Placement:**
   Patients should be cared for in a location determined by their treatment plan:

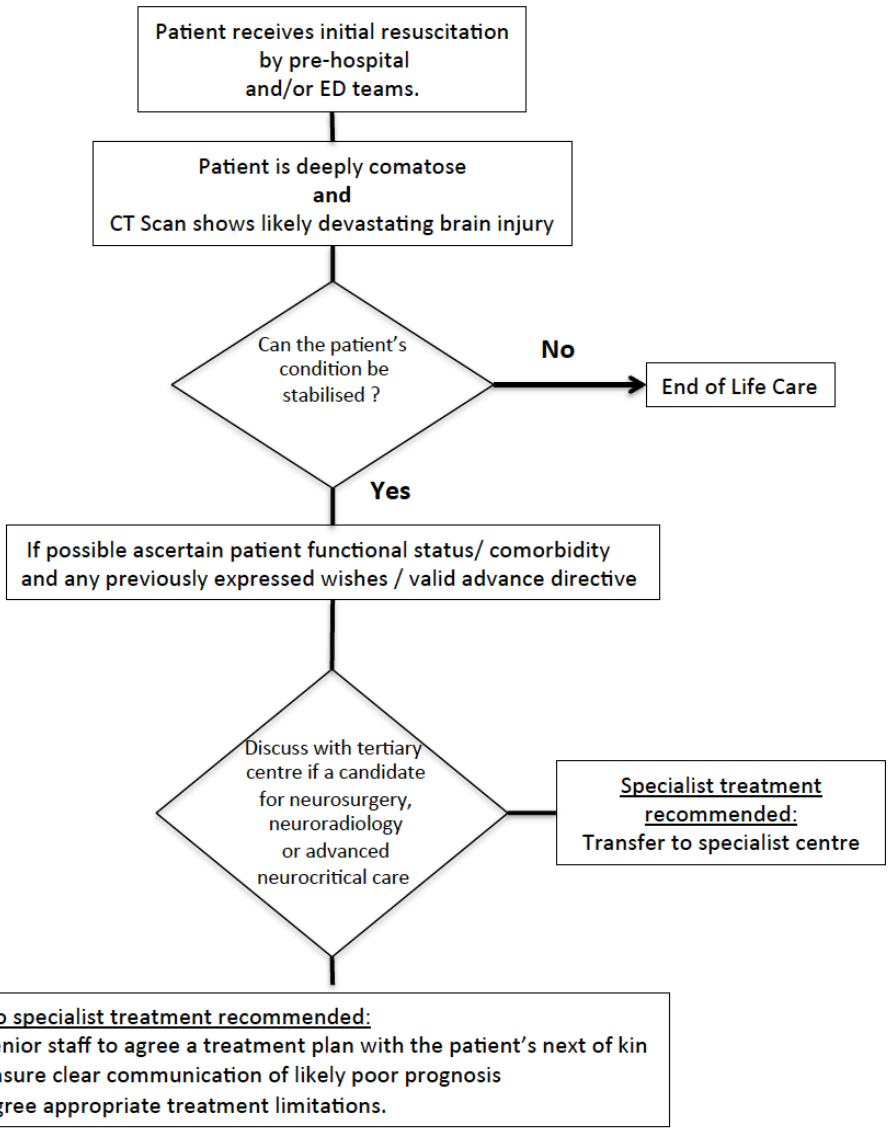
   i. Patients who are unsuitable for critical care treatment should receive care aimed at comfort and dignity in line with local end of life guidelines.
   ii. Patients who may benefit from tertiary treatment should be transferred to a specialist centre.
   iii. All other patients should be admitted to their closest critical care unit for "basic neurocritical care" and assessment of prognosis.

Note: The fact that a patient has not been accepted for tertiary transfer or treatment (e.g. neurosurgery) does not constitute a contra-indication to admission to a non specialist critical care unit for prognostication.

Clear communication with the patient's representatives is essential. The overall prognosis is likely to be poor, there are few (if any) therapeutic options and the development of further organ failures or other signs of deterioration should prompt consideration of treatment limitation or withdrawal of life supporting therapy (WLST). It is important that the patient's representatives understand that a "good" recovery is unlikely, and that the aim of admission is to be certain about this poor prognosis.

Provision of written information may help patient's representatives understand the aims of critical care and we recommend the creation of a "DBI Information Leaflet" for this purpose.

All Wales Pathway for early management of Devastating Brian Injury



Majority of cases:
Admit to local critical care unit for basic neurocritical care.
Re-assess neurology after 72 hours if condition stable.
Re-assess benefits of transfer if improves.

Poor prognosis certain due to combination of DBI with other factors

Provision of end of life care and organ donation consideration in line with local guidelines

Basic Neurocritical Care:

In this document we use the term “Basic Neurocritical Care” to encompass the basic physiological support and serial assessment of condition that can be provided in non-specialist Critical Care units. Further details on suggested treatments are included in the appendices.

We contrast this with “Advanced Neurocritical Care” which includes neurosurgical / neuroradiological treatments as well as specialist critical care monitoring (e.g. Intracranial Pressure monitoring) and other treatments that can only be provided in specialist centres.

At this point we should highlight the previous guidance issued by NICE (CG 176) which states that “transfer would benefit all patients with serious head injuries, Glasgow Coma Score (GCS) 8 or less, irrespective of the need for neurosurgery”. This guideline was issued in 2014 and pre-dates the recent work and consensus statements on DBI. It should be noted that CG 176 does not specifically address the cohort of patients with DBI. Not all DBI is due to trauma, the outcomes for DBI are worse than for traumatic brain injury and at present there are no treatments shown to improve outcome in this patient group. Most patients with DBI will transition to end of life care, and prior to the publication of these guidelines would often not have been admitted to any critical care unit. We do not therefore recommend the transfer of all patients with DBI to specialist centres. Provision of Basic Neurocritical Care in local critical care units has several advantages:

- Preserves the capacity in specialist centres for provision of care that cannot be undertaken elsewhere
- Maintains skills and long term viability of some of the smaller critical care units across Wales
- Spreads any increase in clinical workload more evenly across the critical care network
- Provides end of life care closer to home
- Usually preferred by the patient’s representatives due to shorter travelling distances

It is important to note that the difference between Severe Brain Injury and Devastating Brain Injury, as currently defined, is subject to inter-observer variation. As such, we suggest that the treatment plan should be governed by the opinion of the tertiary teams (usually neurosurgical) as to whether transfer for specialist care may confer benefit for a particular patient.

A key principle is that patients who may benefit from specialist treatment should receive that care.

Note: The decision regarding tertiary transfer lies with the specialist teams, as it does for all tertiary referrals. Despite the lack of evidence, it may be felt appropriate to transfer some patients with DBI for more specialised care. This

subset of patients with DBI who are transferred may change over time as clinical practice evolves.

An improvement in clinical condition during the provision of basic neurocritical care may mandate a "late" transfer and should always trigger re-discussion with specialist colleagues in tertiary centres (NICE CG 176). For example, a patient with an acute subdural haematoma with a GCS of 3/15 may not be a surgical candidate. However, if the patient's GCS improved after admission, then surgical intervention might be re-considered. Good communication between non-specialist and specialist centres is necessary to optimise outcomes while managing resources appropriately across the critical care network.

Note: Timely repatriation of patients, once their specialised care is complete, is essential to maintain the admitting capacity of the specialist centres. Sufficient Critical Care, rehabilitation and long term care resources should be available to enable this repatriation as soon as clinically appropriate.

Assessment of Prognosis:

The key principle underlying these guidelines is that neurological outcome cannot be reliably predicted early in a patient's clinical course. Basic Neurocritical Care is provided to enable assessment of neurological status over a longer period of time in order to ensure that any potential survivors are identified.

It is recommended that withdrawal of life sustaining therapy (WLST) based solely on poor neurological outcome should be deferred until at least 72 hours have elapsed – as is current practice with hypoxic brain injury following cardiac arrest (2).

The following points are offered as guidance to good practice:

- Patients who meet the very strict definition of Brain Stem Death, as laid out in the Academy of Royal College's guidelines (24), may be verified as dead and further treatment deemed futile. It is not necessary to wait 72 hours to certify brain stem death as long as the published guidelines are followed.
- In the absence of brain stem death, life sustaining treatments should not be withdrawn on the basis of poor neurological status alone until at least 72 hours have elapsed.
- The patient's pre-existing health and functional status may have a major impact on likely outcome. Poor functional status is an independent risk factor for poor outcome from DBI and increases the diagnostic certainty of poor outcome
- Reversible causes of unconsciousness should be excluded where appropriate (e.g. Non convulsive status epilepticus, residual sedative effect)

- Patients who remain deeply unconscious with fixed or deteriorating findings on examination (e.g. absent pupillary reflexes) are less and less likely to recover as time goes on
- The occurrence and severity of physiological dysfunction is an independent risk factor for poor outcome, as it is for all critically ill patients. Deteriorating physiological status, or the onset of multiple organ failure, may be appropriate reasons to consider treatment limitation or WLST before 72 hours.
- Some patients may require longer than 72 hours to accurately determine a prognosis. Specific prognostication may depend on the cause of the DBI. Advice from relevant tertiary colleagues or local neurology services may help the assessment of prognosis. In some cases it may be months before the final prognosis is known and long term care and treatment may be needed.
- A patient's previously expressed views (if known) are key factors in deciding "best interests". Some patients may have very clearly expressed wishes that they would not wish to survive in a disabled condition while others may have a view (sometimes supported by religious beliefs) that life should be preserved at all costs. A patient's wishes should be foremost in any decisions regarding treatment. While considering the likely effect of the DBI on the patient's hopes and aspirations for the future, it is important to recognise the limitations of current medical knowledge with regard to prognostication.

- Shared decision making between professionals and the patient's representatives, in line with the Mental Capacity Act (2005), is mandatory. If a patient does not have representatives, and time allows , referral should be made to an Independent Mental Capacity Advocate (IMCA). If consensus cannot be achieved arbitration procedures should be followed. These may include further second opinions, formal medical reports, and sometimes arbitration. In extreme cases, where agreement cannot be achieved, medico-legal advice and application to the courts may be needed. WLST or treatment limitation should not be undertaken until there is agreement from all relevant parties that it is appropriate.

In order to provide appropriate care for DBI patients in local critical care units it may be necessary for extra resourcing, training and provision to be made available to these units. For example, it may be necessary to commission EEG services, or make arrangements for neurology consultants to review patients when necessary. Individual Health Boards and the critical care network should ensure that critical care units have the necessary training, equipment and support to care for these patients.

Treatment Limitation:

Most patients with DBI will not recover. Whilst seeking to reduce the chances of premature WLST, it is important to recognise that the prognosis is generally poor for these patients. In this context it is important not to subject them to futile treatments that may reduce dignity or cause discomfort.

The occurrence of progressive organ dysfunction or failure greatly increases the certainty around the futility of care. Based on this, we recommend a pragmatic approach tailored to the individual circumstances. It may often be appropriate to limit a patient's treatment prior to 72 hours - for example by agreeing a Do Not Attempt Cardio-pulmonary Resuscitation (DNACPR) order. It may also be decided that renal replacement therapy or drug support for a worsening shock state would also be inappropriate.

Clear but sensitive communication with the patient's representatives is essential at all stages of care, but is especially important when discussing treatment limitation.

End of Life Care and Organ Donation:

Issues related to end of life care and organ donation fall outside the remit of these guidelines. The decisions to admit to a critical care unit or to initiate WLST should always be considered separately from issues related to organ donation. The aim of basic neurocritical care and repeated neurological assessment is to improve outcomes from DBI by the avoidance of premature WLST. A secondary effect of admission of more patients with DBI to critical care units may be a reduction in the number of missed organ donation opportunities, but it must be stressed that this is not the aim of these guidelines.

As a principle, issues related to organ donation should not be addressed until futility of care has been determined. However, if the topic is raised by the patient's representatives, an open and honest discussion facilitated by colleagues from the Organ Donation Service should be undertaken. It is worth noting in this context that the National Institute of Health and Clinical Excellence (NICE) guidelines recommend early discussion with specialist colleagues from the Organ Donation Service when consideration of organ donation is a likely outcome (25).

After a decision has been reached that WLST is appropriate and futility has clearly been accepted by the patient's representatives, a discussion should be undertaken with the patient's representatives by the Organ Donation Service and critical care staff with regard to whether an attempt at organ donation is appropriate. Under these guidelines it should be noted that most patients with DBI, where a declaration of futility has been reached, will already be in a critical care unit, and this will greatly ease the management of end of life care and organ donation.

Occasionally, the combination of DBI with other factors may allow a declaration of futility to be made prior to critical care admission. In these circumstances, Health Boards may wish to admit these patients to their critical care unit to facilitate end of life care and discussions around organ donation. Other Health Boards may arrange for such discussions to be undertaken prior to admitting to a critical care unit if critical care is thought to be futile.

We would encourage individual health boards to agree local guidelines for managing end of life care and organ donation.

Some authors have recommended admission to critical care units as a strategy to improve the quality of end of life care (5). In a resource constrained service (4), admissions to critical care for end of life care may reduce the ability of critical care units to admit patients who have a greater potential to benefit. The final responsibility for appropriate use of critical care resource lies with the critical care team.

It is the recommendation of these guidelines that good end of life care can be provided in many different settings (e.g. Emergency Department, Critical Care Unit, general ward or operating theatre suite) and that quality of this care is much more important than the location in which the care is provided. We do not therefore recommend the admission of all patients to critical care for end of life care.

Please also refer to the NICE guidance on end of life care (Quality Standard 13) (25), as well as the 2010 GMC document on Treatment and Care Towards the End of Life in this regard.

Long term care and service evaluation:

At present, long term outcomes for patients with DBI are not known. It is possible that the application of these guidelines may result in greater numbers of patients surviving but with significant disability. This may place an increased burden on rehabilitation and long term care facilities which may in turn require increased resourcing. It is important that the clinical outcomes from the application of these guidelines are monitored by on-going service evaluation to ensure that the treatment offered is providing a net benefit to patients. Given the lack of clinical data in this field at the moment, there is an opportunity for Wales to lead the world by monitoring the outcomes of patients with DBI from different causes. We recommend the creation of a patient registry to evaluate the effects of these guidelines on patient outcomes.

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Appendices:

1) Background and summary of current evidence:

DBI is a relatively common life-threatening emergency and often poses difficult clinical and ethical problems for healthcare professionals and patients' representatives. The evidence base upon which treatment decisions for these patients have been made is widely recognised to be inadequate. A further concern is that historical practice has often been to decline critical care admission to patents with DBI and this may have generated a clinical experience of worse outcomes that is actually seen. These factors, along with the wish to avoid unnecessary distress to patients and family, as well as the need to utilise scarce critical care resources appropriately (3,4), may have contributed to significant variation in practice across Wales.

Over recent years it has become increasingly recognised that accurate prognostication based on early clinical or radiological features is impossible given the current state of medical evidence (1). While the vast majority of patients with DBI seem to die regardless of the treatment offered, there have been anecdotal reports of patients with DBI who have been admitted to critical care units for short term organ support to facilitate organ donation who have subsequently improved and eventually recovered to a reasonable level of health (5).

Based on these relatively few but concerning cases, and also the recommendations issued by the Neurocritical Care Society in the USA in 2015 (1), a tertiary neurosurgery centre in the south west of England changed their admission practice and admitted all patents with DBI to their Critical Care Unit for up to 72 hours of basic neurocritical care to facilitate accurate prognostication. In their first case series of 21 patients, 3 survivors were identified (5).

The period of 72 hours was suggested by the Neurocritical Care Society (1) and was chosen, at least in part, because of the similar pathophysiology seen in hypoxic brain injury following Out of Hospital Cardiac Arrest (OOHCA). In OOHCA, studies have suggested that prognostication based on clinical signs at 72 hours is significantly more accurate than at first presentation (6). Based on this work the European Resuscitation Council in 2015 published guidelines on post resuscitation care (2) recommending that treatment should not be withdrawn solely on the basis of poor neurological status until at least 72 hours have passed. It is hoped that adopting a similar strategy for DBI may reduce the likelihood of treatment being withdrawn prematurely from patients with DBI who might have a possibility of recovery (1,5).

Much evidence has been published over the years regarding outcomes from the various causes of DBI. Many adverse factors have been identified and clinical scoring systems devised. While clinicians need to be aware of this literature several limitations must be highlighted at the outset:

a) There are many different conditions that lead to DBI and they may have different prognoses and risk factors for poor outcome.
b) Clinical scores give a population based risk of a poor outcome for a particular cause of DBI. None are sufficiently accurate at the moment to predict the outcome for an individual patient with acceptable accuracy.
c) Randomised studies are not generally available and are not likely to be performed due to ethical concerns. As such, the level of evidence upon which important clinical decisions must be made is not high.
d) A presumption of poor outcome in the past may have contributed to worsened patient survival in historical observational studies. There is some evidence that improved treatment in recent years has led to an improvement in patient outcomes and so some patients who might previously have met the criteria for DBI would now be classified instead as Severe Brain Injury.
e) Studies often report mortality rates and outcomes in broad cerebral performance categories. Only a minority report socio-economic outcomes. Evidence is also lacking as to what outcomes are satisfactory to patients and this may also vary with patient cohort.
f) There is very little information at the moment about the risks of treatment. These potentially include patient discomfort, loss of dignity and prolongation of the dying process. More worrying is the possibility that increasingly aggressive treatment of patients with DBI could lead to the survival of greater numbers of patients in a severely disabled state. These risks cannot be quantified accurately at the moment from the published evidence.

Traumatic Brain Injury:

Traumatic Brain Injury (TBI) is not a single diagnosis – it encompasses both focal and diffuse, blunt and traumatic, direct and indirect injuries as well as combinations of any of the above. Data from the RAIN study (7), which looked at 2975 TBI patients admitted to UK critical care units, showed an overall unadjusted in-hospital mortality rate of 24%. However, in this patient cohort (which was overall significantly less unwell than the DBI cohort) only 26% of patients had a “favourable” outcome at 6 months with the rest (74%) suffering death or severe disability.

Kotwica et al (8) presented a case series of 111 TBI patients with a presenting GCS of 3/15 which are probably more similar to patients with DBI from TBI. Of these patients 4 out of 111 made “satisfactory” recoveries – a rate of 3.6%. This is low but not negligible.

The evidence available at present does not exclude the possibility of diagnosing irrecoverable TBI in some extreme cases at presentation, for example where there is direct injury to a large part of the cranial vault and/or brain. Gunshot wounds may cause such extreme injury but are not be the only cause.

It should also be mentioned that prognosis in Traumatic Brain Injury is not solely governed by the brain injury. Traumatic Brain Injury often presents as part of polytrauma and associated injuries may also have a strong bearing on

the likely overall prognosis. Injury severity scores are often used on a population basis to predict the overall risk of death in polytrauma (9), but are not accurate enough to allow individual prognostication (10). The additional risks conferred by concurrent polytrauma with DBI enhance the certainty of poor outcome and should be considered.

Subarachnoid Haemorrhage:

Aneurysmal Subarachnoid Haemorrhage (SAH) carries an overall mortality rate of 60% at 6 months (11). Prognostic scores are available based on radiological features or clinical features (chiefly the conscious level at presentation as expressed by the Glasgow Coma Score). The European Guidelines for management of SAH (11) recommend GCS based scoring systems.

It should be noted that even for the highest grades (poorest outcome) of SAH there remains an approximate survival rate of 6-7% with “good” functional status (11). Anecdotally, many of the cases of DBI who have gone on to make good recoveries have been from the SAH group. Particular caution is therefore advised with early prognostication in this group. Unwitnessed seizures at the time of presentation may lead to a low initial GCS and an over-estimation of the SAH grade.

Early aggressive treatment of complications e.g. hydrocephalus or vasospasm, along with prevention of re-bleeding by embolisation of the aneurysmal vessel, may significantly improve the outcome even for patients with high grade SAH. A recent review concluded that up to 50% of survivors from such high grade SAH when treated aggressively may make good functional recoveries. (12).

Intracerebral Haemorrhage and Ischaemic Stroke:

In ischemic and haemorrhagic stroke, higher mortality is associated with high National Institutes for Health Stroke Scale (NIHSS) score (13), advanced age, low/deteriorating GCS, diabetes, haematoma volume, fever, leukocytosis and abnormal renal function (1).
No score as yet has sufficient performance to allow individual patient decisions and early CT scan appearances, particularly in ischaemic stroke, may poorly reflect later functional outcomes. Treatment of ischaemic stroke is a rapidly evolving field with developments in acute stroke care, including thrombolysis, clot retrieval, as well as decompressive Craniotomy for malignant middle cerebral artery infarction, showing varying degrees of promise for improved outcomes. (14).

Co morbidity and functional status:

Decisions regarding appropriateness, or otherwise, of admission to critical care are not based solely on the presenting condition. Whilst increasing age may be associated with a worse prognosis, and in particular impaired

recovery after critical care, other factors are stronger predictors of outcome (15). Presence of severe co-morbid illness, or other life limiting conditions, may make recovery from any period of critical care very difficult (16). Poor pre-existing functional status or frailty may also make successful recovery from critical illness even more difficult, regardless of the severity or otherwise of the presenting condition (17,18). Presence of such co-morbidity or frailty in a patient with DBI may increase the confidence in an early declaration of futility which would not be possible based on the DBI alone. Specific evidence on the effect of functional status in DBI is not available. In general, however, patients who would have been unlikely to benefit from critical care treatments before their DBI would be very unlikely to benefit from such treatment after such a severe illness as a DBI. Published guidance recommends senior clinician decision making in such cases (4,19).

Severity of illness (extracranial):

The critical care literature has long demonstrated the link between severity of illness, as demonstrated by physiological scores such as SAPS, APACHE or SOFA, and outcomes (20). Although partly a reflection of the underlying illness, these physiological changes and the additional risk of death they confer may help refine the prognosis of patients with DBI at presentation, but they probably become more reliable when measured serially (1). They are therefore more useful in on-going treatment decisions following critical care admission rather than as an aid to patient selection for critical care admission. There is one caveat to this - admission to critical care of patients whose physiology cannot be stabilised in the ED is probably futile and very unlikely to lead to a successful outcome. Failure to restore physiological homeostasis with appropriate resuscitation and treatment in the ED represents treatment failure and should prompt consideration of a switch to immediate end of life care.

Evidence from Out of Hospital Cardiac arrest (OOHCA):

Although specifically excluded from this guideline, due to the existence of separate guidance on OOHCA management, a form of DBI caused by cerebral hypoperfusion is relatively common following cardiopulmonary resuscitation. Many studies have shown that prognostication based on neurological signs, such as absent pupillary/corneal reflexes or absent extensor motor response, is significantly more accurate at 72 hours than at presentation (2). Based on this relatively mature evidence base, in 2015 the European Resuscitation Council issued guidance for care of patients following OOHCA that recommended that treatment should not be withdrawn on the basis of poor neurological findings until 72 hours had elapsed (2). Based on the similar pathophysiology, this is considered to be relatively strong supporting evidence for the practice of delaying neurological prognostication in other DBI patients for 72 hours.

Recent work in patients who have been resuscitated from cardiac arrest has show that the incidence of extra-cerebral organ failures has a strong

predictive effect on survival. Non-survivors in general have a higher incidence of renal, cardiovascular, and respiratory failure during their critical care stay than survivors (21). It is likely that the development of such organ failures in patients with DBI would have a similar prognostic value. Development of multiple organ failure in patients with DBI may therefore be a rational basis for declaration of futility earlier than a decision could be made based only on the neurological findings.

2) "Basic Neurocritical Care":

The aim of admission to a non-specialist critical care unit is to provide basic physiological stability and the passage of time to enable an accurate neurological prognosis to be made.

Basic Neurocritical Care in this context is care and treatment that can be provided in local critical care units and comprises:

- Secure airway
- Adequate, but lung protective, ventilation with normoxia and normocarbia. (Note – both hypo and hypercarbia should be avoided)
- Maintenance of blood pressure at a level appropriate to the underlying diagnosis avoiding usually either extreme hypo or hypertension. The setting of an individual blood pressure target for a particular patient is the responsibility of the attending critical care consultant and advice from specialist centres may be sought in individual cases. Examples of specific blood pressure targets from the current literature (2017) include:
    - Patients with intracerebral haemorrhage may benefit from having their systolic blood pressure reduced to <140-180 mmHg to reduce the risks of re-bleeding (22)
    - Patients with clinical or radiological features of high intracranial pressure should have their Systolic BP maintained >110 mmHg (23). It should be noted that ICP monitoring or Cerebral Perfusion Pressure (CPP) based treatment for patients with DBI is not currently supported by the literature.
    - Patients with aneurysmal sub arachnoid haemorrhage should usually have their Systolic BP maintained >160 mmHg after 48 hours because the risk of vasospasm exceeds that of re-bleeding (even if the aneurysm remains "unsecured") (11,12).

- Treatment of any other medical conditions (e.g. chest sepsis) or associated traumatic injuries as appropriate
- Avoidance of fever
- Normal blood glucose
- Gastroprophylaxis, enteral feeding and bowel care
- Normal electrolyte levels (including phosphate)
- Patients with aneurysmal SAH should be prescribed Nimodipine 60mg enterally 4 hourly to reduce the risk of vasospasm

- DVT prophylaxis by mechanical means. After 24-48 hours consider low dose thromboprophylaxis depending on the diagnosis and advice of a tertiary centre
- Drug treatment of any co-existing seizures (continuous EEG monitoring is rarely required) or diabetes insipidus.
- Serial neurological assessment; facilitated by use of short acting sedatives and analgesics (if any sedation at all is needed).
- Possible alternative causes of coma should be considered and / or excluded including:
    - Hypothermia
    - Hypothyroidism or other endocrine abnormality
    - CSF infection
    - Non convulsive status epilepticus (diagnosed by formal EEG)
    - Encephalopathy; uraemic, hepatic or other cause
- Repeat CT scanning
- Performing of brain stem death tests in line with the guidelines set down by the Academy of Royal Colleges (24) if clinically appropriate

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