Outcome After Severe Traumatic Brain Injury (TBI)

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Recommendations

Measuring outcome after therapy is an obvious part of evidence-based medicine. Using standard classification of recommendations may not be appropriate for this topic. To our knowledge, there has not been performed any controlled studies to evaluate whether or not outcome should be measured after traumatic brain injury.

Level I

There is insufficient data to support a Level I recommendation for this topic.

Level II

There is insufficient data to support a Level II recommendation for this topic.

Level III

Survival, quality of life and functional outcomes should be measured after treatment of severe traumatic brain injury.

70.1 Overview

Severe traumatic brain injury is a leading cause of disability and death, especially among young adults. Most TBI deaths occur within the first week, and 30-day mortality is 20–30%. Physical function generally improves quickly and steadily over the first few months, and overall recovery takes place mainly during the first year. Most of the long-term disability from TBI is caused by neurobehavioural problems (cognitive impairment, depression, anxiety and aggression) which constitute an important barrier to reentry to society. The proportion of vegetative patients seems to be stable at 5–10%. Quality of life normally improves during the first year.

Factors predicting poor prognosis are age above 40 years, low Glasgow Coma Score, hypoxia and hypotension, absent pupil reactivity, the presence of major extracranial injury, pre-injury unemployment, pre-injury substance abuse and severe disability at admission to rehabilitation.

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Tips, Tricks, and Pitfalls

- Updated population registries are the best tools for follow-up.
- If available, prospectively collected patient data are of great benefit.
- Validated questionnaires and scoring systems should be used.

70.2 Background

Traumatic brain injury is a leading cause of disability and death, especially among young adults (Fleminger and Ponsford 2005). In addition, trauma care is expensive and resources invested must be wisely, ethically and effectively used. Measuring outcomes after TBI is therefore important.

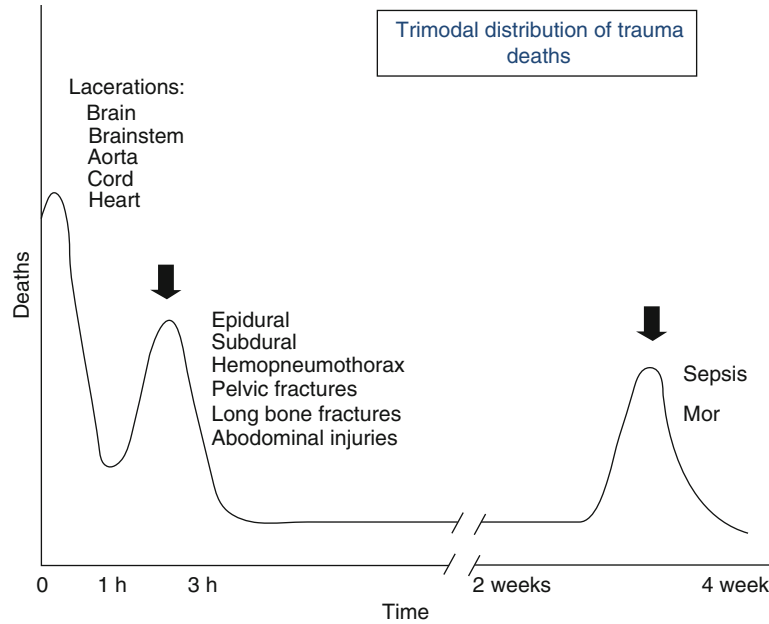
Primary aims of health care are to reduce mortality and morbidity and to maintain or improve functional capacity and quality of life (Black et al. 2001). While a trauma patient is critically ill, the question is whether or not the patient is going to survive. After the acute phase of life-threatening injuries, long-term outcomes become increasingly more important, and the ultimate question is what kind of life the patient can expect to live. For the last decades, there has been more focus on such non-mortality outcomes, especially functional status and quality of life (Ridley 2002).

The length of the follow-up depends on the outcome parameter. Survival should be traced until the survival curves of patients parallel that of a comparative group (Ridley 2001). For non-mortality outcomes, the follow-up should continue until the patients have regained their pre-injury level or until the progress in the rehabilitation process flattens.

The shift of focus towards patients' perspectives implies assessment of outcome beyond the hospital stay. Obviously, long-term outcome after severe TBI depends on the whole health-care system. The rehabilitation period may last for several months or even years. One must therefore be careful in ascribing certain changes in outcome to the performance of only one of the links in the chain of trauma care.

70.2.1 Survival After Traumatic Brain Injury

Survival is clearly defined and easy to measure. Outcome research, however, depends on national databases containing the date of birth and death for the citizens. To limit the number of patients lost to follow-up, the registries need to be updated continuously. A classic trimodal distribution of deaths following trauma has been described (Trunkey 1983):



70.2.1.1 Immediate Deaths

Half of trauma deaths occur immediately within seconds to minutes and are due to overwhelming damage to vital structures such as the heart, major vessels, brain and upper spinal cord. In the absence of immediate and aggressive intervention, these deaths are largely unavoidable and can only be limited by preventive measures and legislation.

70.2.1.2 Deaths Occurring from Minutes up to Four Hours After Injury

These deaths account for 30% of trauma deaths and are predominantly a result of major haemorrhage, major chest injuries and traumatic brain injuries. During this period, the so called Golden Hour, a well-organised trauma care system reducing the time interval between injury and definitive treatment, plays an essential role in the improvement of survival after major trauma.

70.2.1.3 Late Deaths Occurring from Days to Weeks After Injury

This third peak, accounting for 20% of trauma deaths, has been attributed to the development of sepsis and multiple organ failure.

Improvements in pre-hospital, resuscitative and operative care of trauma patients have resulted in more patients surviving the initial phases of care and thus requiring intensive care. Critical evaluation of the ICU phase of trauma care has been reported to be the key element in further improvement of outcome after severe trauma (Davis et al. 1991).

Mortality from severe TBI has fallen drastically over the past decades. In the 1970s, a mortality rate of 55% was common. Today, reported 30-day mortality is in the range 20–30% (Ghajar 2000). Most of the deaths occur within the first week after trauma.

70.2.2 Non-mortality Outcomes After Traumatic Brain Injury

Non-mortality outcomes include functional outcome and quality of life.

70.2.2.1 Functional Outcomes

A wide range of sequelae may follow traumatic brain injury, from physical impairment like ataxia or incontinence to neuropsychiatric/neuropsychological problems. Functional outcome describes both physical and mental capability and capacity. The term is frequently and incorrectly used interchangeably with quality of life. Since functional outcome does not include satisfaction or well-being, it can be objectively measured by a researcher. A patient's perception, satisfaction and quality of life may vary independently of functional outcome. Functional outcome can be divided into physical function (impairment and disability), mental function (cognitive and neuropsychological function) and recovery.

Physical Function After TBI

Early post-injury follow-up has traditionally assessed physical disability, which is quite easy to measure and describe. The range of physical sequelae after TBI is, however, wide and includes impairments in motor function, strength, coordination, sensation and cranial nerve function (Wilde et al. 2010). Physical function generally improves quickly and steadily over the first few months following TBI, whereafter a gradual plateauing normally takes place.

Mental Function After TBI

Neuropsychiatric/neuropsychological recovery is a far more complex process, which may not reach baseline even after more than 2 years (Schretlen and Shapiro 2003). Most of the long-term disability from TBI is caused by neurobehavioural problems regarding memory, attention, executive function, behavioural control, mood regulation, anxiety and personality changes. These factors constitute the most important challenge for rehabilitation and interfere with employment, relationships and a normal social life. A review reports prevalence of major depression (25–50%), cognitive impairment (25–70%), anxiety (10–70%) and aggression (30%) following TBI

(Vaishnavi et al. 2009). Another review found that in severe TBI, most of the cognitive recovery takes place within the first 6–18 months after injury, whereafter some improvement may continue at a slower pace (Ruttan et al. 2008). This meta-analysis showed clear cognitive deficits both at approximately 1 and 4.5 years after trauma but found that most of the deficits in attention, executive functions and long-term memory were better explained by primary deficits in working memory. A deficit in speed of processing seems to be a common finding in many studies.

Recovery After TBI

There are numerous outcome measures in TBI research, but the Glasgow Outcome Scale (GOS) is the most commonly used (Wilde et al. 2010). This single-item scale comprises five categories: (1) death, (2) persistent vegetative (minimal responsiveness), (3) severe disability (conscious but disable, dependent for daily support), (4) moderate disability (disable but independent, can work in sheltered settings), and (5) good recovery (resumption of normal life despite minor deficits). A recent study of traumatic brain injury patients with an initial Glasgow Coma Scale ≤ 8 found that at 3 months, almost half of the patients had GOS scores 4 and 5 (favourable outcomes). Other studies have found less favourable outcomes with 46% mortality, 26% persistent vegetative or severely disabled and only 28% having a GOS of 4 and 5 at 6 months (Tasaki et al. 2009).

Several large studies use the GOS at 6 months post injury, since most of the improvements take place during this period. The proportion of vegetative patients seems to be stable at 5–10% (Ghajar 2000).

The Karnofsky Performance Scale (Karnofsky Index) is a generic and useful instrument for measuring functional status, especially the ability to carry out activities of daily living, see Table 70.1 (Schag et al. 1984).

There are two important cut-off points in this scale – score above 50 indicates ability to care for oneself, and score above 70 indicates ability to work and perform normal activities.

Table 70.1 The Karnofsky performance scale

Description	Percentage (%)
Normal; no complaints; no evidence of diseases	100
Abel to carry on normal activity; minor signs and symptoms of diseases	90
Normal activity with effort; some signs and symptoms of diseases	80
Cares for self; unable to carry on normal activity or do work	70
Requires occasional assistance, but is able to care for most personal needs	60
Requires considerable assistance and frequent medical care	50
Disabled; requires special case and assistance	40
Severely disabled; hospitalization indicated although dead not imminent	30
Very risk; hospitalization necessary; requires active support treatment	20
Moribund; fatal processes progressing rapidly	10
Dead	0

70.2.2.2 Quality of Life

Quality of life (QOL) is the subjective experience of life satisfaction and evaluation of life as a whole. Quality of life after TBI should be narrowed to health-related quality of life (HRQOL), which can be defined as the level of well-being and satisfaction associated with an individual's life and how this is affected by disease, accident and treatments (Ridley 2002).

Traumatic brain injury can have serious implications for quality of life, but there are surprisingly few studies published on HRQOL after TBI. Many studies have tried to score quality of life by extrapolating functional status, which is of highly questionable value.

During the acute phase after TBI (<3 months), it can be difficult to assess QOL due to reduced consciousness. In the rehabilitation phase (<1 year) and later, repeated assessment is recommended (Bullinger et al. 2002). Too many different QOL measures have been developed, and for comparison and useful interpretation, only validated measures should be used. The Short Form 36 (SF-36) is a widely used generic measure that has been found to be both reliable

and valid for use in many patients groups, including patients with TBI (Findler et al. 2001). The SF-36 is a 36-item questionnaire that assesses eight scales: physical functioning, role limitations due to physical health, body pain, general health, vitality, social functioning, role limitations due to emotional problems and general mental health. A prospective study using the SF-36 found that there is a significant improvement of HRQOL from 6 to 12 months after severe TBI (GCS < 9 for more than 24 h), while there were no major differences between TBI patients with and without polytrauma at 6 or 12 months. This indicates that TBI has a major influence on outcome and QOL after trauma (Lippert-Gruner et al. 2007).

A new trauma-specific international instrument for assessing HRQOL after TBI has been developed, the Quality of Life after Brain Injury (QOLIBRI) (Hawthorne et al. 2011). Validation of the QOLIBRI indicates that this measure is appropriate in TBI studies.

There are some other studies addressing HRQOL after TBI, and they show that TBI has a significant long-term impact on all QOL domains, with lower scores than non-injured controls or normal population reference groups. TBI has a more profound effect on psychosocial domains than on physical domains (Jaracz and Kozubski 2008). Chronic pain is a common complication of TBI with a reported prevalence of up to 58% (Nampiaparampil 2008).

70.2.3 Predictors of Outcome After Traumatic Brain Injury

A predictor gives knowledge in advance about what most likely will happen. Predictors or prognostic factors may constitute a basis for decision making with respect to diagnostic and therapeutic procedures and follow-up. Early identification of patients at risk may improve the outcome after severe TBI through the allocation of expertise, resources and increased attention. Based on risk factors, patients can be stratified into different risk groups. Risk stratification is essential for describing a patient population and is a prerequisite for scientific evaluation of treatment regimens. It is also necessary for comparison of quality of care within and between hospitals and healthcare systems. Identification and evaluation of unexpected non-survivors, i.e. patients who die in spite of low predicted mortality, and unexpected survivors, i.e. patients who survive in spite of high predicted mortality, may improve quality in trauma systems.

In patients with severe TBI the following factors predict poor prognosis, i.e. death or severe disability at 6 months: age above 40 years, low Glasgow Coma Score (linear relation), absent pupil reactivity and the presence of major extracranial injury (Perel et al. 2008). The impact of hypoxia and hypotension is discussed in Chap. 26. Pre-injury unemployment, pre-injury substance abuse and more disability at admission to rehabilitation are found to be important predictors of long-term (more than 1 year) disability (Willemse-van Son et al. 2007).

70.3 Specific Paediatric Concerns

All the uncertainties and doubts regarding pathophysiology, therapy and outcome that apply to TBI in adults are valid also for paediatric TBI. In children, TBI is frequent, but there are little data on prognosis and outcome for these patients (Stocchetti et al. 2010). Based on the concept of greater ‘plasticity’ in the immature brain, there has been a mistaken optimism concerning outcomes after TBI in children, and a misconception that outcomes in general are superior to those for similar injuries in adults (Forsyth 2010).

Mortality after severe TBI in children is 10–30% (Stocchetti et al. 2010). In a French study reporting a mortality rate of 22%, mortality varied with age and was significantly higher in children <2 years of age (Ducrocq et al. 2006). After 6 months recovery, 39% had a poor outcome defined as GOS ≤ 3, but only 0.8% were in a persistent vegetative state.

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