4. ABI Assessment Tools

On behalf of the ERABI Research Group

4.1 Defining Severity of Injury

ABI severity is usually classified according to the level of altered consciousness experienced by the patient following injury. Consciousness levels following ABI can range from transient disorientation to deep coma. Patients are classified as having a mild, moderate or severe ABI according to their level of consciousness at the time of initial assessment. Various measures of altered consciousness are used in practice to determine injury severity. Common measures include the Glasgow Coma Scale (GCS), the duration of loss of consciousness (LOC), and the duration of post-traumatic amnesia (PTA).

The Glasgow Coma Scale

The GCS is one of the most widely used measures of altered consciousness. Developed by Teasdale and Jennett (1974, 1976) the GCS is one of the most widely used standard measures of altered consciousness. The GCS is comprised of three subsections (see Table 1): eye opening, best motor response and verbal response. Higher scores on the GCS are indicative of an increased level of consciousness.

Table 1. Subsections of GCS

Response/Item	Points
Eye Opening	
Spontaneous	4
To speech	3
To pain	2
None	1
Motor Response	
Obeys commands	6
Localizes pain	5
Withdrawal (from painful stimulus)	4
Flexion (decorticate posturing)	3
Extension (decerebrate posturing)	2
None	1
Verbal Response	
Oriented	5
Confused	4
Inappropriate	3
Incomprehensible	2
None	1

The total GCS score (i.e. the sum of the three subscores) ranges from 3–15, with a score of 13–15 indicating a “mild” injury, a score of 9–12 indicating a “moderate” injury, and a score of 3–8 indicating a “severe” injury (Campbell 2000; Murdoch & Theodoros 2001).

Duration of Loss of Consciousness

For moderate to severe TBI, duration of LOC appears to be a valid measure of injury severity. LOC of less than 30 minutes is considered to represent a mild injury, 30 minutes to 6 hours of LOC is considered a “moderate” injury, and between 6 and 48 hours is considered “severe.” When duration of LOC exceeds 48 hours, the injury is considered as being “very severe” (Campbell 2000).

Post-Traumatic Amnesia

PTA is the time period following injury for which the conscious patient has no recall for events. PTA is formally defined by some authors as the period following emergence from coma in which the patient

may appear confused, disoriented, or agitated (Campbell 2000). The length of PTA frequently is proportional to the severity of injury. Injury severity is defined as "mild" if the duration of PTA is less than 24 hours; moderate if between 1 and 7 days and "severe" if PTA exceeds 7 days. PTA exceeding 1 month is considered to represent a "very severe" injury (Campbell 2000; Russel 1932).

Table 2. Definitions of Injury Severity

Mild	**Moderate**	**Severe**	**Very Severe**
PTA <24 hours	PTA 1–7 days	PTA >7 days	PTA >1 month
GCS 13–15	GCS 9–12	GCS 3–8	
LOC <30 minutes	LOC 30 minutes–6 hours	LOC 6–48 hours	LOC >48 hours

4.2 Assessment Tools

Agitated Behaviour Scale

Q1. What does the Agitated Behaviour Scale test?

- Assesses agitation in patients who had sustained a TBI (Corrigan 1989). According to Levy et al. (2005), despite the availability of the scale, agitation remains unmeasured by most who work with the TBI population.

Q2. Describe the Agitated Behaviour Scale.

- The scale, which began as a 39-item scale, was reduced to 14 items with each item scored 1–4 (i.e. from "absent" to "present to an extreme degree").
- The scale which was originally tested by nurses, occupational therapists, physiotherapists and other hospital staff, was designed to be used by allied health professionals (Corrigan 1989).

Q3. Describe some of the key Agitated Behaviour Scale numbers.

- The total score is calculated by adding the ratings (from 1–4) for each of the 14 items.
- The scale can also be divided into three subscales.
- "Disinhibition" subscale includes items 1, 2, 3, 6, 7, 8, 9 and 10.
- "Aggression" subscale includes items 3, 4, 5 and 14.
- "Lability" subscale includes items 11, 12 and 13 (Corrigan & Bogner 1994). Individual score of ≥22 on the ABS indicates "high" agitation; a score of ≤21 indicates "low" agitation (Corrigan & Mysiw 1988).

Q4. What are the advantages of the Agitated Behaviour Scale?

- Designed specifically for those who had sustained a TBI (Corrigan 1989).
- Strong internal consistency and inter-rater reliability (Bogner et al. 1999).
- Strong relationship between cognition and agitation; higher scores on the Mini Mental State Examination (MMSE) and the Functional Independence Measure (FIM) cognitive subscales were significantly related to lower scores on the ABS (Bogner et al. 2001; Corrigan & Bogner 1994).
- Length (14 questions), availability, cost, and the amount of time needed to administer it (<30 minutes) make the scale very practical.

Q5. What are the disadvantages of the Agitated Behaviour Scale?

- Has yet to be validated within a wider range of rehabilitation facilities (Bogner & Corrigan 1995).
- Risk of over-diagnosis of agitation (Corrigan & Mysiw 1988).

Practicality

***Interpretability*:** Scores on the ABS are easy to interpret: severely agitated ≥36, moderately agitated 29–35, mildly agitated 22–28, and no agitation <22 (Bogner et al. 2000).
***Acceptability*:** The scale is available free of charge and requires little time for training and administration.
***Feasibility*:** The ABS requires little time to complete and can be completed by all allied health professionals.

Table 3. Agitated Behaviour Scale Evaluation Summary

Reliability		Validity		Responsiveness		
Rigor	**Results**	**Rigor**	**Results**	**Rigor**	**Results**	**Floor/ceiling**
+++	**+++(IR) +++(IC)**	**++**	**++**	**++**	**++**	**N/A**

NOTE: +++=Excellent; ++=Adequate; +=Poor; N/A=Insufficient Information; TR=Test Re-test; IC=Internal Consistency; IO=Interobserver.

Berg Balance Scale

Q1. What does the Berg Balance Scale test?

- A quantitative assessment of balance in older adults (Berg et al. 1989). It was intended for use in monitoring the clinical status of patients as well as the effectiveness of treatment over time (Berg et al. 1995).

Q2. Describe the Berg Balance Scale.

- The Berg Balance Scale (BBS) consists of 14 items requiring subjects to maintain positions or complete movement tasks of varying levels of difficulty.
- Administration of the scale only requires a ruler, a stopwatch, chair, step or stool, room to turn 360 degrees and 10–15 minutes. It is administered via direct observation of task completion (Berg et al. 1995; Juneja et al. 1998).
- Each of the 14 items receives a score of 0–4 based on the subject's ability to meet the specific time and distance requirements of the test. A score of 0 represents an "inability to complete the item" and a score of 4 represents the "ability to complete the task independently."

Q3. Describe some of the key Berg Balance Scale numbers.

- Scores of <45 out of 56 are generally accepted as being indicative of balance impairment (Berg et al. 1992; Zwick et al. 2000).

Q4. What are the advantages of the Berg Balance Scale?

- BBS measures a number of different aspects of balance, both static and dynamic, and does so with minimal space and equipment requirements (Nakamura et al. 1999; Whitney et al. 1998; Zwick et al. 2000).
- No specialized training required to administer the BBS (Nakamura et al. 1999); high levels of reliability have been reported when the test was administered by untrained assessors (Berg et al. 1995).
- High inter-rater and intra-rater reliability and internal consistency in the version translated into Japanese (Matsushima et al. 2014).

Q5. What are the disadvantages of the Berg Balance Scale?

- BBS has been thoroughly evaluated for use among populations of individuals who have experienced stroke; at present, information regarding the reliability and validity of the BBS when used among patients with TBI/ABI is limited.
- No common standards exist for the relationship between BBS score and mobility status or the requirement for mobility aids (Wee et al. 2003); the rating scales associated with each item, while numerically identical, have different operational definitions for each number or score (e.g. a score of "2" is defined differently and has a different associated level of difficulty from item to item; Kornetti et al. 2004).
- No common score associated with successful item completion (Kornetti et al. 2004), which makes subsequent interpretations difficult.
- Rasch analysis revealed that some item ratings from the BBS were not used at all or underutilized, and others were unable to distinguish between individuals with different levels of ability (Kornetti et al. 2004).
- BBS takes somewhat longer to administer than other balance measures (Whitney et al. 1998); furthermore, it may not be suitable for the evaluation of active, elderly persons, as the items included are not sufficiently challenging for this group and a ceiling effect may be noted (Berg et al. 1989; Zwick et al. 2000).

Practicality

***Interpretability*:** While the reliability and validity of the scale are excellent, there are no common standards for the interpretation of BBS scores though there is an accepted cutoff point for the presence of balance impairment.
***Acceptability*:** This direct observation test would not be suited for severely affected patients as it assesses only one balance item while sitting. Furthermore, active individuals would find it too simple. The scale is not suited for use by proxy.
***Feasibility*:** The BBS requires no specialized training to administer as well as relatively little equipment or space.

Table 6. Berg Balance Scale Evaluation Summary

Reliability		Validity		Responsiveness		
Rigor	**Results**	**Rigor**	**Results**	**Rigor**	**Results**	**Floor/ceiling**
++	**+++(TR) +++(IO) +++ (IC)**	**+++**	**+++**	**+++**	**+++**	**varied**

NOTE: +++=Excellent; ++=Adequate; +=Poor; N/A=Insufficient Information; TR=Test Re-test; IC=Internal Consistency; IO=Interobserver; varied *(re. floor/ceiling effects; mixed results)*.

Community Balance and Mobility Scale

Q1. What does the Community Balance and Mobility Scale test?

- Evaluates balance and mobility skills in individuals who have experienced mild to moderate TBI (Inness et al. 1999).

Q2. Describe the Community Balance and Mobility Scale.

- The scale is a performance-based measure developed specifically for use in assessment of individuals with mild to moderate TBI (Inness et al. 1999).

Q3. Describe some of the key Community Balance and Mobility Scale numbers.

- The scale is comprised of 13 items; each item is rated on a 6-point scale from 0–5 where a score of 5 represents the "most successful completion of the scale item" (Butcher et al. 2004; Inness et al. 1999).

Q4. What are the advantages of the Community Balance and Mobility Scale?

- Developed specifically for use in assessment of individuals with mild to moderate TBI.
- May have increased sensitivity to change when used within this population compared to more established measures such as the BBS (Inness et al. 2011).

Q5. What are the disadvantages of the Community Balance and Mobility Scale?

- May be assessing a construct more similar to "dynamic mobility" rather than balance per se (Inness et al. 2011).
- Literature regarding reliability, validity or practical application of the scale is extremely limited and comes from the scale authors only.
- Further and broader evaluation of the scale's psychometric properties is required.
- Not appropriate for use on individuals with severe ABI whose ambulation is affected; the CBMS was developed for people who are ambulatory (Inness et al. 1999).

Practicality

Interpretability: Not enough information available.
Acceptability: Not enough information available.
***Feasibility*:** Not enough information available.

Table 7. Community Balance and Mobility Scale Evaluation Summary

Reliability		Validity		Responsiveness		
Rigor	Results	Rigor	Results	Rigor	Results	Floor/ceiling
+	+++(TR) +++(IR)	+	+	+	+++	N/A

NOTE: +++=Excellent; ++=Adequate; +=Poor; N/A=Insufficient Information; TR=Test Re-test; IC=Internal Consistency; IO=Interobserver.

Community Integration Questionnaire

Q1. What does the Community Integration Questionnaire test?

- The Community Integration Questionnaire (CIQ; Willer et al. 1993) was intended as a brief assessment of community integration or the degree to which an individual with TBI is able to perform appropriate roles within the home and community.
- In order to achieve higher levels of reliability, the CIQ uses behavioural indicators of integration and does not include items focused on feelings or emotional status (Dijkers 1997; Willer et al. 1994).
- The CIQ was developed for inclusion in the National Institute on Disability and Rehabilitation Research TBI model systems National Database in the United States (Dijkers 1997).

Q2. Describe the Community Integration Questionnaire.

- The CIQ assesses handicap, which is viewed by the scale authors as the opposite of integration (Willer et al. 1993) in three domains: home integration (i.e. active participation in the operation of the home or household), social integration (i.e. participation in social activities outside the home), and productivity (i.e. regular performance of work, school and/or volunteer activities).
- The scale is comprised of 15 items in three corresponding subscales each of which has a different number of items and subscores (Sander et al. 1999; Willer et al. 1994).
- The CIQ may be administered via self-completion, face-to-face or telephone interviews (Hall et al. 1996). If the individual with TBI is unable to complete the assessment, the questionnaire may be completed by proxy (Willer et al. 1994).
- There are two versions of the questionnaire available, one for completion by the person with TBI and one for completion by a suitable proxy (e.g. family member, close friend, significant other; Sander et al. 1999).
- The CIQ requires approximately 15 minutes to complete (Hall et al. 1996; Zhang et al. 2002).

Q3. Describe some of the key Community Integration Questionnaire numbers.

- The home integration subscale consists of five items and the social integration subscale consists of six items; each item is scored on a scale from 0–2 where a score of 2 represents the greatest degree of integration.
- The productivity subscale consists of four questions with responses weighted to provide a total of 7 points. Scores from each of the subscales are summed to provide an overall CIQ score. The maximum possible score is 29, which reflects complete community integration (Hall et al. 1996).

Q4. What are the advantages of the Community Integration Questionnaire?

- Widely used in the assessment of community integration for individuals with TBI.
- Originally developed by an expert panel that included individuals with TBI, suggesting that items have face validity (Willer et al. 1994; Willer et al. 1993).
- Can be completed quickly and easily by most individuals with TBI or by an appropriate proxy.
- CIQ focuses more on behaviour than emotional states, which promotes better agreement between patient and proxy ratings (Cusick et al. 2000; Dijkers 1997).

Q5. What are the disadvantages of the Community Integration Questionnaire?

- While the CIQ was developed to assess handicap as defined under the International Classification of Impairments, Disabilities and Handicaps (ICIDH), the CIQ does not appear to assess all of the domains included in the World Health Organisation (WHO) definition of handicap (Dijkers 1997); indeed, under the current definitions provided by the International Classification of Functioning, Disability and Health (World Health Organisation 2001), CIQ items may reflect activities more than participation (Kuipers et al. 2004).
- The reduction of items from 47 to 15 based on factor analysis excluded items not loading onto one of the three predetermined factors that might have provided a more comprehensive assessment of handicap and/or participation.
- CIQ is most effective when used to assess Caucasians in comparison to Black and Hispanic populations (Lequerica et al. 2013).
- CIQ does not measure integration skills, the success of integration activities from the point of view of the individual with TBI, or the feelings/meaning associated with integration activities (Willer et al. 1993; Zhang et al. 2002).
- What the CIQ measures appears to be somewhat inconsistent; some items measure the frequency with which activities are eprformed, while others measure the assistance or supervision required in order to perform an activity (Dijkers 1997; Zhang et al. 2002).
- Age, gender and level of education have all been reported to have an effect on CIQ scores (Dijkers 1997; Kaplan 2001; Heinemann & Whiteneck 1995).
- In an assessment of the factor structure and validity of the CIQ, Sander and colleagues (1999) identified two items that appeared problematic; it was recommended that the childcare item and the frequency of shopping item both be removed.

Practicality

***Interpretability*:** The CIQ is widely used. However, no norms are currently available. There is no basis for determining that an individual's level of integration on the CIQ is or is not normal (Dijkers 1997).
***Acceptability*:** The scale is short and simple and represents little patient burden. It has been used successfully with proxy respondents.
***Feasibility*:** No special training is required to administer the CIQ. The scale is free, but should be requested from the scale author. It has been used in longitudinal studies to show change over time.

Table 8. Community Integration Questionnaire Evaluation Summary

Reliability		Validity		Responsiveness		
Rigor	Results	Rigor	Results	Rigor	Results	Floor/ceiling
++	++(TR) ++(IO) ++ (IC)	++	++	++	+ (p-values only)	+ (ceiling)

NOTE: +++=Excellent; ++=Adequate; +=Poor; N/A=Insufficient Information; TR=Test Re-test; IC=Internal Consistency; IO=Interobserver.

Disability Rating Scale

Q1. What does the Disability Rating Scale test?

- Provides quantitative information regarding the progress of individuals with severe head injury from "coma to community" (Rappaport et al. 1982).
- The Disability Rating Scale (DRS) was designed to reflect changes in the following areas: arousal and awareness, cognitive ability to deal with problems around self-care, degree of physical dependence, and psychosocial adaptability as reflected in the ability to do useful work (Rappaport et al. 1982).
- The DRS was developed and tested in a rehabilitation setting among individuals who had experienced moderate to severe TBI (Hall 1997).

Q2. Describe the Disability Rating Scale.

- The DRS is comprised of eight items in four categories: arousal, awareness and responsivity, cognitive ability for self-care activities, dependence on others, and psychosocial adaptability (Rappaport et al. 1982).
- Each item has its own rating scale ranging from 0–3 or 0–5 and is measured either in ½- or 1-point increments. The total or composite score is calculated by summing the ratings for all eight items.
- Administration of the scale may be via direct observation or interview (Hall et al. 1993). When necessary, collateral sources of information may be used to complete the ratings (Rappaport et al. 1982).
- The DRS is simple to administer and requires approximately 5 minutes to complete (Hall 1997; Hall et al. 1993).

Q3. Describe some of the key Disability Rating Scale numbers.

- Lower scores are associated with less disability. The overall score can be used to assign the individual to one of 10 disability outcome categories ranging from "no disability" (DRS score=0) to "extreme vegetative state" (DRS score=29) and "death" (DRS score=30; Fleming & Maas 1994; Hall et al. 1996).
- It has been recommended that ½ point scoring increments rather than whole points should be employed in order to increase the precision and sensitivity of the instrument when assessing higher functioning individuals (Hall et al. 1993). When subjects do not fit whole-point definitions for cognitive ability, self-care items, dependence on others, and employability ½ points can be awarded; total scores with ½ points are rounded down for the purposes of

assignment to an outcome category (Hammond et al. 2001). The rating form available for download has included the ½ point scoring option. When using the ½ point scoring option, the DRS does appear to be sensitive to change between discharge and one-year and even 5-year follow-ups; however, year-by-year change is not captured by DRS ratings more than one year post-injury (Hammond et al. 2001).

Q4. What are the advantages of the Disability Rating Scale?

- A single assessment comprised of items spanning all major dimensions of the ICIDH (Hall et al. 1996; Rappaport et al. 1982).
- Brief and simple, allowing for the ongoing assessment of recovery from injury to community re-integration.
- Assign scores to an outcome category with relatively little loss of information (Gouvier et al. 1987).
- Provides a quick snapshot of an individual's overall disability status by assigning scores to an outcome category with relatively little loss of information (Hall et al. 1993).
- Appears to be more reliable and valid than the Ranchos Los Amigos Level of Cognitive Functioning Scale (RLA-LCFS), and may be more sensitive to change than categorical rankings such as the Glasgow Outcome Scale (GOS; Brazil 1992).
- GCS scores can be obtained from the DRS (Hall 1997).

Q5. What are the disadvantages of the Disability Rating Scale?

- Descriptions of what corresponds to successful item performance at each rating level are not precise and subscales do not clearly identify areas for intervention (Brazil 1992).
- The sequelae of head injury that are included for assessment are limited and do not include formal cognitive assessment (Brazil 1992).
- Assesses only general rather than specific function or functional change (Hall & Johnston 1994).
- May be most useful as a means to characterize sample severity and provide the means for comparison to other groups, but it is not particularly sensitive to the effects of treatments designed to ameliorate specific functional limitations or social participation (Hall et al. 1993).
- Not well suited to patients with mild TBI or very severe impairments (Hall et al. 1996; Hall et al. 1993; Wilson et al. 2000).

Practicality

Interpretability: The DRS is widely used and is part of the TBI Model Systems Database. It provides a quick, accessible snapshot of outcome of disability in terms of general function.
Acceptability: The simplicity and brevity associated with the DRS would suggest little to no patient burden associated with its administration. Ratings provided by family members are strongly correlated with those completed by healthcare team members.
Feasibility: The DRS is free to use and copy. Training materials are also provided free of charge and a training video is available for a modest fee. The DRS seems to be able to detect significant change over time and may be well suited for group comparisons.

Table 9. Disability Rating Scale Evaluation Summary

Reliability		Validity		Responsiveness		
Rigor	**Results**	**Rigor**	**Results**	**Rigor**	**Results**	**Floor/ceiling**
+	**+++(TR) +++(IO) ++ (IC)**	**+++**	**+++**	**++**	**+ (p-values only)**	**+ (ceiling)**

NOTE: +++=Excellent; ++=Adequate; +=Poor; N/A=Insufficient Information; TR=Test Re-test; IC=Internal Consistency; IO=Interobserver.

Functional Independence Measure

Q1. What does the Functional Independence Measure test?

- The Functional Independence Measure (FIM) test is a rating scale that assesses physical and cognitive disability in terms of burden of care, that is, the FIM score is intended to represent the burden of caring for that individual.

Q2. Describe the Functional Independence Measure.

- The FIM is a composite measure consisting of 18 items assessing six areas of function: self-care, sphincter control, mobility, locomotion, communication and social cognition. These fall into two basic domains: physical (13 items) and cognitive (five items).
- The 13 physical items are based on those found on the Barthel Index (BI), while the cognitive items are intended to assess social interaction, problem-solving and memory.
- The physical items are collectively referred to as the motor-FIM while the remaining five items are referred to as the cognitive-FIM.
- Administration of the FIM requires training and certification. The most common approach to administration is direct observation. The FIM takes approximately 30 minutes to administer and score. The developers of the FIM further recommend that the rating be derived by consensus opinion of a multi-disciplinary team after a period of observation.

Q3. Describe some of the key Functional Independence Measure numbers.

- Each item is scored on a 7-point Likert scale indicative of the amount of assistance required to perform each item (1=total assistance, 7=total independence). A simple summed score of 18–126 is obtained where 18 represents “complete dependence/total assistance” and 126 represents “complete independence.” Subscale scores for the physical and cognitive domains may also be used and may yield more useful information than when they are combined into a single score (Linacre et al. 1994).

Q4. What are the advantages of the Functional Independence Measure?

- Widely used, well accepted, and a generic measure of burden of care employed in inpatient rehabilitation settings.
- FIM may yield more detailed information on patients compared to other assessment tools such as the BI, which has fewer items and response options (Hobart et al. 2001).

Q5. What are the disadvantages of the Functional Independence Measure?

- Reliability of the FIM is dependent upon the individual conducting the assessment.
- Training and education in administration of the test is a prerequisite for good levels of inter-rater reliability (Cavanagh et al. 2000).
- The use of a single summed raw score may be misleading as it gives the appearance of a continuous scale.
- The contribution of the cognitive subscale to the scale as a whole is questionable; it has been shown to have less reliability and responsiveness than either the motor-FIM or the total FIM (Hobart et al. 2001; Ottenbacher et al. 1996; van der Putten et al. 1999).
- The limited cognitive assessment may be inadequate for the assessment of individuals who have experienced a TBI (Hall & Johnston 1994).
- FIM is intended for use during inpatient rehabilitation and is not well suited to ongoing, long-term assessment in community-based settings (Gurka et al. 1999).

Practicality

***Interpretability*:** The FIM has been well studied for its validity and reliability. It is widely used and has one scoring system increasing the opportunity for comparison. It is important to remember, when interpreting FIM scores, that it is an ordinal not continuous scale.
***Acceptability*:** Multiple modes of administration have been assessed including telephone interview. The FIM has been studied for use by proxy respondents.
***Feasibility*:** Training and education of persons to administer the FIM, in addition to the price of the scale itself, may represent a significant cost. Use of interview formats may make the FIM more feasible for longitudinal assessment.

Table 10. Functional Independence Measure Evaluation Summary

Reliability		Validity		Responsiveness		
Rigor	**Results**	**Rigor**	**Results**	**Rigor**	**Results**	**Floor/ceiling**
+++	**+++(TR) +++(IO) +++ (IC)**	**+++**	**++**	**+++**	**++**	**++**

NOTE: +++=Excellent; ++=Adequate; +=Poor; N/A=Insufficient Information; TR=Test Re-test; IC=Internal Consistency; IO=Interobserver.

Functional Assessment Measure

Q1. What does the Functional Assessment Measure test?

- Created specifically for use with patients with brain injury in an attempt to enhance the appropriateness of the FIM for this specific population (Alcott et al. 1997; Hall et al. 1993; Hobart et al. 2001).
- The FIM contains only five cognitive items, which may limit its content validity in TBI populations (Hall 1994). The Functional Assessment Measure (FAM) test does not stand alone as an assessment tool, but rather consists of 12 items that are added to the 18 FIM items.

- The 12 additional items were developed by a team of clinicians representing each of the disciplines in a rehabilitation model (Hall et al. 1993) and are intended to emphasize cognitive, communicative and psychosocial function (McPherson et al. 1996).

Q2. Describe the Functional Assessment Measure.

- The 12 FAM items are swallowing, car transfer, community access, reading, writing, speech intelligibility, emotional status, adjustment to limitations, employability, orientation, attention, and safety judgment.
- Each item is rated using the same 7-point scale used on the FIM. Like the FIM, the FIM+FAM also consists of two subscales, one representing physical or motor functioning and one representing cognitive/psychosocial function. The FIM+FAM requires approximately 35 minutes to administer (Hall & Johnston 1994).

Q3. Describe some of the key Functional Independence + Assessment Measure numbers.

- The total score for the FIM+FAM is 210, 112 for the motor FIM+FAM and 98 for the cognitive subscale (Gurka et al. 1999). Higher scores signify greater independence.

Q4. What are the advantages of the Functional Independence + Assessment Measure?

- Intended specifically for assessment during inpatient rehabilitation; FAM items are better suited for evaluation post discharge from inpatient rehabilitation, and may extend the applicability of the scale beyond the time frame of the original FIM (Gurka et al. 1999).
- Addition of the FAM items to the FIM appears to expand the range of abilities assessed (Hall et al. 1993).

Q5. What are the disadvantages of the Functional Independence + Assessment Measure?

- The scale requires trained raters; the use of untrained raters may result in lower scale reliability (Hall et al. 1993).
- Many of the FAM items have been identified as difficult to score, specifically with respect to items related to adjustment to limitations, emotion, employability, community mobility, safety judgment, attention, and speech intelligibility (Turner-Stokes et al. 1999); items in the expanded psychosocial/cognitive subscale seem to include more abstract concepts requiring raters to make more subjective assessments than was necessary for the more objective and observable behavioural items included on the original FIM (Hall et al., 1993; McPherson et al. 1996).
- Validity of FAM has not been clearly established (Hobart et al. 2001).
- Psychosocial/cognitive FIM+FAM does not correlate well with measures of handicap, such as the London Handicap Scale or as strongly as one might expect with the mental component summary of the Medical Outcomes Study Short Form 36 (SF-36; Hobart et al. 2001).
- Overall, the added length and increased training requirements associated with the FIM+FAM do not seem to offer any substantial advantage over the FIM (Hobart et al. 2001; McPherson & Pentland 1997); while the FIM+FAM appears to evaluate a somewhat broader range of abilities (Hall et al. 1993), reports of ceiling effects associated with the FIM+FAM are varied and reported effect sizes are approximately the same as those reported for the FIM (Hobart et al. 2001).

Practicality

***Interpretability*:** The 18-FIM items are widely used and recognized. However, the FAM items are more difficult to rate reliably and the validity of the FAM is not well established.
***Acceptability*:** Alternate modes of administration have not been examined and FAM items have not been evaluated for use in assessment by proxy.
***Feasibility*:** The addition of FAM items to the FIM creates a longer assessment requiring the involvement of additional raters in team consensus and more training for these raters. While the FAM items are freely available, use of the FIM items requires purchase of the scale as well as training and certification.

Table 11. Functional Assessment Measure Evaluation Summary

Reliability		Validity		Responsiveness		
Rigor	**Results**	**Rigor**	**Results**	**Rigor**	**Results**	**Floor/ceiling**
++	**+++(TR) ++(IO) +++ (IC)**	**+**	**++**	**++**	**++**	**varied**

NOTE: +++=Excellent; ++=Adequate; +=Poor; N/A=insufficient information; TR=Test Re-test; IC=Internal Consistency; IO=Interobserver; varied *(re. floor/ceiling effects; mixed results)*.

Galveston Orientation and Amnesia Test

Q1. What does the Galveston Orientation and Amnesia Test assess?

- The Galveston Orientation and Amnesia Test (GOAT) was intended to evaluate orientation to time, place, and person as well as provide an estimation of the intervals prior to and following the injury for which there is no recall (Levin et al. 1979).
- The GOAT is a brief and simple mental status examination developed for use by health professionals at the bedside or in the emergency department (Levin et al. 1979; van Baalen et al. 2003).

Q2. Describe the Galveston Orientation and Amnesia Test.

- Assessment consists of 10 items regarding orientation to person (name, address, and birthdate), place (city/town and building they are in) and time (current time, date, month, year and date of hospital admission) as well as memory of events both after and prior to the injury (Bode et al. 2000).
- Oral questions are posed directly to the patient who may respond either orally or in writing (Jain et al. 2000; Levin et al. 1979). Error points are awarded for each incorrect response, summed and deducted from 100 to arrive at the total score. Both the scale and instructions for assigning error points are available in Levin et al. (1979).

Q3. Describe some of the key Galveston Orientation and Amnesia Test numbers.

- The duration of PTA is defined as the period following coma in which the GOAT score is <75 (Levin et al. 1979). PTA is considered to have ended if a score of ≥75 is achieved on three consecutive administrations (Novack et al. 2000; Wade 1992; Zafonte et al. 1997). In the initial standardization study of Levin et al. (1979) using patients with mild head injury as a reference

group, it was determined that a score of 75 represented a level achieved by 92% of the standardization group. No patients with mild head injury scored less than 65 on the GOAT.
- Scores between 66 and 75 are considered borderline abnormal while scores above 75 fall into the range considered normal within the reference group (Levin et al. 1979; van Baalen et al. 2003).

Q4. What are the advantages of the Galveston Orientation and Amnesia Test?

- Provides an objective rating of early cognitive recovery, eliminating the need for sometimes ambiguous terminology used to describe mental status, such as "confused" (Levin et al. 1979).
- Rasch analysis demonstrated that items on the GOAT represent a wide range of difficulty suggesting that the scale is useful for assessing patients with a wide range of cognitive impairments (Bode et al. 2000).

Q5. What are the disadvantages of the Galveston Orientation and Amnesia Test?

- Administration of GOAT is difficult with non-verbal patients (Novack et al. 2000).
- The requirement for oral or written expression may result in penalizing patients who are experiencing deficits of expression but not in orientation or in the retrieval or consolidation of memory (Jain et al. 2000).
- Eight of the 10 GOAT items evaluate orientation while only two examine memory (Forrester et al. 1994).
- An aphasia-specific version of the GOAT is available, however it requires further evaluation
- For items in which partial credit is used, Rasch analysis revealed a step disorder (Bogner et al. 2000); collapsing these response categories to a simple dichotomy (right vs. wrong) eliminated the disorder and allowed the construction of an equal interval measure from the GOAT (Bode et al. 2000).

Practicality

Interpretability: The GOAT provides an objective assessment with a standardized cut-off for the presence of PTA.
Acceptability: In its original form, the GOAT is not well suited to assessment of patients with aphasia.
Feasibility: The GOAT may be too lengthy for a simple, repeated bedside assessment of mental status. However, it is freely available and can be used by any healthcare professional.

Table 12. Galveston Orientation and Amnesia Test Evaluation Summary

Reliability		Validity		Responsiveness		
Rigor	**Results**	**Rigor**	**Results**	**Rigor**	**Results**	**Floor/ceiling**
++	**+++(TR) ++(IO) +++ (IC)**	**+**	**++**	**++**	**++**	**varied**

NOTE: +++=Excellent; ++=Adequate; +=Poor; N/A=Insufficient Information; TR=Test Re-test; IC=Internal Consistency; IO=Interobserver; varied *(re. floor/ceiling effects; mixed results)*.

Glasgow Coma Scale

Q1. What does the Glasgow Coma Scale test?

- The Glasgow Come Scale (GCS) test is a quick, simple, and objective assessment of level of consciousness (Teasdale & Jennett 1974, 1976; Teasdale et al. 1978).

Q2. Describe the Glasgow Coma Scale.

- The GCS is an observer rating scale consisting of 15 items in three basic categories: motor response (six items), verbal response (five items), and eye opening (four items). Points are awarded for the best response in each category and category scores are summed to provide a global GCS score (Sternbach 2000; Wade 1992).
- Total summed scores range from 3 (totally un-responsiveness) to 15 (alert, fully responsive). A total of ≤8 is used to separate coma from non-coma (Wade 1992).

Q3. Describe some of the key Glasgow Coma Scale numbers.

- The lowest total score of 3 likely represents fatal damage, especially if both pupils fail to respond to light and if oculovestibular responses are absent. A score <8 is typically indicative of coma (Koch et al. 2007). Other categorical divisions are: scores of 13–15 represent "mild" injury, scores of 9–12 represent "moderate" injury, and scores of ≤8 represent "severe" injury (Sternbach 2000).

Q4. What are the advantages of the Glasgow Coma Scale?

- Simple, straightforward and brief bedside assessment.
- Most familiar and widely used instrument in the assessment of level of consciousness.
- Established categories related to the presence of coma and severity of injury.
- GCS scores are a significant predictor of outcome following head injury.
- Can be used by various groups of healthcare professionals regardless of level of education or Intensive Care Unit experience.

Q5. What are the disadvantages of the Glasgow Coma Scale?

- GCS is based on the assumption that evaluation of eye opening is sufficient to represent brainstem arousal systems activity.
- Consistent rating among inexperienced raters may be inaccurate; percentage agreement between inexperienced individuals and expert raters ranged from 58.3–83.3% (Rowley & Fielding 1991).
- The application of painful stimulus is controversial and there is a great deal of variability in the means and location of its application (Edwards 2001; Lowry 1999).
- Use of a global score may result in a loss of information that adversely affects the predictive accuracy of the GCS (Healey et al. 2003; Teasdale et al. 1983; Teoh et al. 2000).
- Motor response has the greatest influence on the summary score and results are skewed toward this component (Bhatty & Kapoor 1993).
- Individuals with the same GCS scores in varying permutations can have significantly different risks for mortality (Teoh et al. 2000).
- Patients who have been intubated or sedated, those with paralysis or facial swelling, patients

with hypotension, hypoxia, alcohol or illicit drug intoxication all may not be able to provide responses to all categories of GCS items for reasons unrelated to head trauma (Demetriades et al. 2004; Oppenheim & Camins 1992; Rutledge et al. 1996).

Q6. How is the Glasgow Coma Scale used to predict outcomes?

- Higher initial GCS scores tend to predict better recovery.
- However, prediction of prognosis and severity may be improved by considering the computer tomography (CT) scan results and other factors.
- Hypoxia and hypotension can decrease the GCS; therefore, GCS values after resuscitation from cardiopulmonary insults are more specific.
- Sedative medications can decrease GCS values and should be used only after full neurological evaluation (Koch et al. 2007).

Table 13. GCS Scores 6–48 Hours Post Injury and Mortality in Patients with TBI

GCS Score	Mortality
3	65%
4	45%
5	35%
6	24%
7–13	10–15%

(Fearnside et al. 1993)

In the United States, 746 patients with closed head injuries entered into the Traumatic Coma Data Bank were reviewed to determine the relationship between the initial GCS score and outcomes (Marshall et al. 1991). In this study, the interval from injury to outcome assessment was quite variable and ranged from 11 to 1,199 days, with a median of 674 days. The mortality rate for those with an initial post-traumatic GCS score of 3 was 78.4%, 55.9% for those with an initial GCS score of 4, and 40.2% for those with an initial GCS score of 5. Of note, however, is that 4.1%, 6.3%, and 12.2% of the three groups, respectively, had a good outcome. In a large study of 46,977 patients with head injury, the relationship between GCS scores of 3–15 and mortality was investigated (Gennarelli et al. 1994). A sharp progressive increase in mortality was noted in patients who presented to the Emergency Room with a GCS score of 3–8. In 109 adults with acute subdural hematomas, Phuenpathom et al. (1993) also showed a significant inverse relationship with GCS score (best score within 24 hours) and mortality.

Table 14. GCS Scores Within the First 24 hours and Mortality at 6 Months Post Injury

GCS Score	Number of Patients	Mortality (n)
3	37	37 (100%)
4	10	9 (90%)
5	8	5 (63%)
6	6	2 (33%)
7	9	2 (22%)
8–15	39	0 (0%)

(Phuenpathom et al. 1993)

In a series of 115 patients with epidural hematomas, Kuday et al. (1994) found that the initial GCS score was the single most important factor affecting outcome ($p<0.00001$). Because of the strong association with the initial GCS score and outcomes, a number of investigators have studied the predictive value of the initial GCS score using various logistic regression techniques (Hartley et al. 1995; Kaufmann et al. 1992; Stablein et al. 1980; Thatcher et al. 1991). Thatcher et al. (1991) used multimodal statistical models to study the ability of the initial GCS score or the GCS score obtained at a mean of 7.5 days after the injury to predict outcome at 1 year after injury for 162 patients with TBI. When based on the initial GCS score, only 68.6% of those predicted to have a good outcome and 76.5% of those predicted to have a poor outcome actually had such outcomes at 1 year. If the later GCS score was used for predictions, there was a significant increase in the rate of correct predictions for a good outcome (80.6%), but the rate of correct predictions for a poor outcome remained essentially unchanged (78.6%).

Kaufman and colleagues described the accuracy of outcome predictions of an experienced neurosurgeon for 100 patients with severe TBI (Kaufmann et al. 1992). Outcomes were categorized as dead/vegetative, severely disabled, or capable of independent survival, and were predicted based on the best GCS score obtained within 24 hours of injury. Age, pupils, blood pressure, heart rate, laboratory values, and initial CT scans were also considered. Correct prognosis was estimated in only 56% of the cases.

Table 15. Analysis of Predicted and Actual Outcomes

GOS	Predicted/Actual Outcomes
Dead/Vegetative	35/24
Severe Disability	23/22
Independent	42/65

(Kaufmann et al. 1992)

The table above reveals that predictions were best for very bad or very good outcomes. In addition, poor outcomes were overestimated by 32–52%, while good outcomes were underestimated by 35%. It should be emphasized that most of these studies looked at the least discriminate scenario (e.g. reduction of potential outcomes to two or at most three groups). When attempts were made to predict more precisely into one of the five categories of the GOS, the predictive accuracy of the initial GCS score was poor (Jennett et al. 1976).

Practicality

***Interpretability*:** The GCS is the most familiar, most widely-used early assessment of level of consciousness. It has established categories related to the presence of coma and severity of injury.
***Acceptability*:** A very brief, simple, observer rater scale. The application of painful stimulus is controversial. Assessment of all components is compromised by aggressive, early interventions such as intubation and sedation.
***Feasibility*:** The scale is simple to administer and designed for use by any health professional. Lack of experience and variability in assessment may result in inaccurate assessment. Training and standardized procedures are recommended.

Table 16. Glasgow Coma Scale Evaluation Summary

Reliability		Validity		Responsiveness		
Rigor	Results	Rigor	Results	Rigor	Results	Floor/ceiling
+	++(IO)	++	++	N/A	N/A	N/A

NOTE: +++=Excellent; ++=Adequate; +=Poor; N/A=Insufficient Information; TR=Test Re-test; IC=Internal Consistency; IO=Interobserver.

Glasgow Outcome Scale

Q1. What does the Glasgow Outcome Scale test?

- The Glasgow Outcome Scale (GOS) is a practical index of social outcome following head injury designed to complement the GCS as the basis of a predictive system (Jennett & Bond 1975; Jennett et al. 1981).

Q2. Describe the Glasgow Outcome Scale.

- The GOS is a simple, hierarchical rating scale with a limited number of broad categories. The scale focuses on how head injury has affected function in major life areas and is not intended to provide detailed information on specific deficits (Wilson et al. 1998).
- Individuals within any single outcome category represent a range of abilities (Jennett & Bond 1975). The assignment of an individual to an outcome category should be based on the results of a structured interview focused on social and personal functional ability (Jennett et al. 1981). The final rating is based on the lowest category of outcome indicated in the interview (Wilson et al. 2000).
- Structured interviews and guidelines for administration are available for the GOS and Extended Glasgow Outcome Scale (GOSE; Wilson et al. 1998). Each interview incorporates information regarding pre-injury status, thereby providing a means for determining the effect of head injury from the effects of pre-existing conditions or circumstances (Pettigrew et al. 1998; Wilson et al. 1998). While use of the structured interview has increased the reliability compared to postal and telephone administration, face-to face interview remains the preferred method to determine a GOS rating (Wilson et al. 2002).

Q3. Describe some of the key Glasgow Outcome Scale numbers.

- Patients are assigned to one of five possible outcome categories: death, persistent vegetative state, severe disability, moderate disability, and good recovery (Jennett & Bond 1975). In 1981, a revision to the scale was proposed to better classify patients who had regained consciousness (Jennett et al. 1981).
- In the GOSE, each of the three categories applicable to conscious patients are subdivided into an upper and lower band resulting in eight possible categories. GOS ratings can be derived from the GOSE by collapsing these subdivisions (Wilson et al. 2000).

Q4. What are the advantages of the Glasgow Outcome Scale?

- Most widely used and accepted measure of outcome following head injury (Wade 1992); adopted widely for use in clinical trials (Hellawell et al. 2000; Wade 1992; Wilson et al. 2000).
- Simple, reliable, quick to administer, broadly applicable, and contains clinically relevant

categories (Wilson et al. 2000).

Q5. What are the disadvantages of the Glasgow Outcome Scale?

- Does not provide detailed information regarding specific disabilities or handicaps.
- Categories are broad and the scale does not reflect subtle improvements in functional status (Pettigrew et al. 1998).
- Individuals may achieve considerable improvement in ability, but not change outcome category (Brooks et al. 1986).
- GOS rating was intended primarily to provide an overall summary of outcome and facilitate comparison, not to describe specific areas of dysfunction (Pettigrew et al. 1998).
- GOS may be subject to loss of information and decreased sensitivity since outcomes are expressed dichotomously (i.e. poor or unfavourable vs. independent or favourable; Wilson et al. 1998).
- GOS categories were originally described according to a range of features, but specific criteria were not defined for each of the different outcomes; this lack of clarity may have compromised the reliability of the scale by introducing an element of subjectivity on the part of the rater (Maas et al. 1983; Teasdale et al. 1998).
- Attempts to increase the sensitivity of the GOS by subdividing the upper three categories into an upper and lower band was associated with decreased consistency in category assignments (Maas et a. 1983); however, the structured interview and guidelines created by Wilson et al. (1998; described previously) have alleviated much of the difficulty surrounding ambiguous assignment criteria.

Practicality

Interpretability: The GOS is widely used and accepted. The GOS provides an overall assessment suitable for the comparison of outcomes at the group level.
Acceptability: The brevity and simplicity of the GOS facilitates patient compliance. The GOS has been studied for use by telephone and mail administration. Structured interviews improve the reliability of administration.
Feasibility: The GOS can be used by professionals from various backgrounds and does not require any physical, psychiatric or neurologic examination. It is well-suited to busy clinical settings and large scale research trials.

Table 17. Glasgow Outcome Scale Evaluation Summary

Reliability		Validity		Responsiveness		
Rigor	**Results**	**Rigor**	**Results**	**Rigor**	**Results**	**Floor/ceiling**
+	**++(TR) ++(IO)**	**++**	**+++**	**+**	**+ (p-values only)**	**N/A**

NOTE: +++=Excellent; ++=Adequate; +=Poor; N/A=Insufficient Information; TR=Test Re-test; IC=Internal Consistency; IO=Interobserver.

Mayo-Portland Adaptability Inventory

Q1. What does the Mayo-Portland Adaptability Inventory test?

- The Mayo-Portland Adaptability Inventory (MPAI) is based on an earlier scale, the Portland Adaptability Inventory (Lezak 1987). Specifically designed for use in individuals during the post-acute period following ABI, the scale represents the sequelae of ABI through the use of key indicators of abilities, activities, and social participation (Malec 2004b).
- Assessment with the MPAI is intended to yield information applicable to the development and ongoing evaluation of rehabilitation services within this population (Malec et al. 2003).

Q2. Describe the Mayo-Portland Adaptability Inventory.

- The original version of the MPAI consisted of six subscales: physical/medical, cognition, emotion, everyday activities, social behaviours, and behaviours (Bohac et al. 1997). Items were rated to reflect distinctions between impairment, disability and handicap as defined by the WHO's ICIDH (Malec et al. 2000; Malec et al. 2003).
- The MPAI has undergone successive revisions based on ongoing Rasch and multivariate analyses. The most current version is the MPAI-4, which evaluates the general dimension of sequelae of ABI in the three sub-dimensions of ability, adjustment and participation (Malec 2004a).
- The MPAI-4 was designed to be completed by professional staff, individuals who have experienced brain injury, and their significant others. Ratings provided by any two or more of these groups can be combined to provide a more comprehensive composite score (Malec et al. 2003). When administered by professional staff, the ratings should be completed by team consensus. The MPAI-4 is free of charge.

Q3. Describe some of the key Mayo-Portland Adaptability Inventory numbers.

- The MPAI-4 consists of 29 items in three subscales, the Ability Index, the Adjustment Index and the Participation Index, plus an additional six items that are not included in the MPAI-4 score. The first 29 scale items are intended to reflect the current status of the individual with brain injury without attempting to determine whether their status might be influenced by factors other than ABI. The additional six unscored items are intended to identify the presence of other factors that may be contributing to the individual's current status (Malec & Lezak 2003).
- In general, items are rated on a 5-point scale from 0–4, where a score of 0 represents the "most favourable outcome of independence" and a score of 4 represents the "presence of severe problems." A worksheet is provided that guides the user through the scoring and re-scoring of items. Following any necessary re-scoring, item scores are summed for each subscale to provide a raw score for that index. After making adjustments for items appearing in more than one index, subscale raw scores are summed to provide an overall adaptability index score. Raw scores for the indices and total scale may be converted to T-scores with a mean of 50 and a standard deviation of 10 using the tables provided in the manual (Malec et al. 2003). T-scores provided are based on data sets from two populations of individuals with ABI. They have not been referenced to non-ABI samples. In general, when compared to reference populations with ABI, total T-scores represent the following: <30 indicates a "good" outcome, 30–40 indicates

"mild" limitations, 40–50 indicates "mild to moderate" limitations, 50–60 indicates "moderate to severe" difficulties, and above 60 suggests "severe" limitations (Malec & Lezak 2003).

Q4. What are the advantages of the Mayo-Portland Adaptability Inventory?

- Readily available assessment of post-acute sequelae of ABI.
- The Participation Index may be administered independently to provide a quick evaluation of participation outcomes.
- Differences in ratings between staff members or significant others and the individual with ABI may provide a measure of impaired self-awareness (Malec 2004a; Malec & Degiorgio 2002).

Q5. What are the disadvantages of the Mayo-Portland Adaptability Inventory?

- Not recommended for individuals with very severe ABI (Malec & Lezak 2003).
- No published validation or reliability studies of the scale are currently available outside of those published by the original developers of the scale.
- Items may be misplaced; self-care, for instance, is part of the Participation Index; in an earlier analysis, it was stated that it was more conceptually sound to place self-care items with other basic skills such as use of hands, mobility and speech (Bohac et al. 1997).
- Significant overlap between subscales also exist (e.g. initiation, social contact and leisure skills/recreation are assigned to more than one index).

Practicality

***Interpretability*:** Tables are provided—raw scores converted to standardized T-scores based on a national sample (n=386) or regional sample (n=134). Truly normative data is not available for the purposes of comparison.
***Acceptability*:** May be completed by patients and significant others with trained professionals available to provide assistance.
***Feasibility*:** The MPAI-4 is free to download and copy. Administration, scoring and interpretation should be undertaken by trained professionals. The manual also contains a recommendation that a person experienced in advanced psychometrics should be available. To maintain high levels of reliability, assessment should be completed by team consensus.

Table 18. Mayo-Portland Adaptability Inventory Evaluation Summary

Reliability		Validity		Responsiveness		
Rigor	**Results**	**Rigor**	**Results**	**Rigor**	**Results**	**Floor/ceiling**
+	**+++ (IC)**	**+**	**++**	**+**	**+ (p-values only)**	**N/A**

NOTE: +++=Excellent; ++=Adequate; +=Poor; N/A=Insufficient Information; TR=Test Re-test; IC=Internal Consistency; IO=Interobserver.

Medical Outcomes Study Short Form 36

Q1. What does the Medical Outcomes Study Short Form 36 test?

- The Short Form 36 (SF-36) test is a generic health survey created to assess health status in the general population as part of the Medical Outcomes Study (Ware & Sherbourne 1992). It is comprised of 36 items drawn from the original 245 items generated by that study (McHorney et al. 1993; Ware & Sherbourne 1992).

Q2. Describe the Medical Outcomes Study Short Form 36.

- Items are organized into eight dimensions or subscales: physical functioning, physical role functioning, bodily pain, social functioning, general mental health, emotional role functioning, vitality, and general health perceptions. It also includes two questions intended to estimate the change in health status that occurred over the past year.
- These two questions remain separate from the eight subscales and are not scored. With the exception of the general change in health status questions, subjects are asked to respond with reference to the past 4 weeks. An acute version of the SF-36 refers to problems in the past week only (McDowell & Jenkinson 1996).

Q3. Describe some of the key Medical Outcomes Study Short Form 36 numbers.

- The recommended scoring system uses a weighted Likert system for each item. Items within subscales are summed to provide a score for each subscale or dimension. Each of the eight summed scores is linearly transformed onto a scale from 0–100 to provide a score for each scale.
- In addition, a physical component (PCS) and mental component score (MCS) can be derived from the scale items. Standardized population data for several countries is available for the SF-36 (McDowell & Jenkinson 1996). The component scores have also been standardized with a mean of 50 and standard deviation of 10 (Finch et al. 2002).

Q4. What are the advantages of the Medical Outcomes Study Short Form 36?

- Simple to administer; either form (self-completed or interview) takes less than 10 minutes to complete (Hayes et al. 1995).
- As a self-completed, mailed questionnaire, it has been shown to have reasonably high response rates: 83% (Brazier et al. 1992; O'Mahony et al. 1998), 75–83% (Dorman et al. 1997), 85% (Dorman et al. 1999), 82% overall and 69% for those over the age of 85 (Walters et al. 2001).
- Appropriate for longitudinal serial assessment of recovery in a mixed group of patients with one of cerebrovascular accident, TBI, or spinal cord dysfunction (Callahan et al. 2005).
- Valid, reliable and sensitive measure of outcome in the adult TBI population (Emanuelson et al. 2003; Findler et al. 2001).

Q5. What are the disadvantages of the Medical Outcomes Study Short Form 36?

- Completion rates have been lower among older patients when administered as a self-completion form (Brazier et al. 1996; Brazil 1992; Hayes et al. 1995); thus postal administration

of the SF-36 may not be appropriate for use among older adults.

- Data completeness may be indicative of respondent acceptance and understanding of the survey (Andresen et al. 1999; O'Mahony et al. 1998); for instance, when asked about work or vigorous activity, older respondents identified these questions as pertinent for much younger people and not relevant to their own situation (Hayes et al. 1995).
- The SF-36 does not lend itself to the generation of an overall summary score; the use of a 2-dimensional model consisting of a MCS and PCS can account for only 60% of the variance in SF-36 scores, suggesting a significant loss of information when the 2-component model is used.
- Not as sensitive to patients with moderate/severe TBI as those with mild TBI (Emanuelson et al. 2003).
- SF-36 cannot be used in patients who are too impaired to complete the questionnaire on their own.
- Considerable disagreement between patient and proxy assessments may exist (Ocampo et al. 1997).

Practicality

***Interpretability*:** Use of scale scores and summary component scores represents a loss of information and decreases potential clinical interpretability. Standardized norms for several countries are available for the SF-36.
***Acceptability*:** Completion times are approximately 10 minutes for either self-completed or interview administered questionnaires. Some items have been questioned for their relevance to elderly populations. The SF-36 has been studied for use by proxy, however, agreement rates are low and reliability of the test decreased when proxy respondents completed assessments.
***Feasibility*:** The SF-36 questionnaire can be administered by self-completion questionnaire or by interview (either on the telephone or in-person). It has been used as a mail survey with reasonably high completion rates reported, however, data is more complete when interview administration is used. Permission to use the instrument and additional information regarding its administration and scoring should be obtained from the Medical Outcomes Trust.

Table 19. Short Form-36 Evaluation Summary

Reliability		Validity		Responsiveness		
Rigor	**Results**	**Rigor**	**Results**	**Rigor**	**Results**	**Floor/ceiling**
+++	**++(TR) ++ (IC)**	**+++**	**+++**	**++**	**+++**	**+**

NOTE: +++=Excellent; ++=Adequate; +=Poor; N/A=Insufficient Information; TR=Test Re-test; IC=Internal Consistency; IO=Interobserver.

Mini Mental State Examination

Q1. What does the Mini Mental State Examination test?

- The Mini Mental State Examination (MMSE) test was developed as a brief screening tool to provide a quantitative assessment of cognitive impairment and to record cognitive changes over time (Folstein et al. 1975). While the tool's original application was the detection of

dementia within a psychiatric setting, its use has become more widespread.

Q2. Describe the Mini Mental State Examination.

- The MMSE consists of 11 simple questions or tasks. Typically, these are grouped into seven cognitive domains: orientation to time, orientation to place, registration of three words, attention and calculation, recall of three words, language, and visual construction. Administration by a trained interviewer takes approximately 10 minutes.
- An expanded version of the MMSE, the modified mini mental state examination (3MS) was developed by Teng and Chui (1987) to increase the content, number, and difficulty of items included in the assessment.

Q3. Describe some of the key Mini Mental State Examination numbers.

- The test yields a total score of 30 and provides a picture of the subject's present cognitive performance based on direct observation of test items/tasks. A score of 23–24 is the generally accepted cutoff point indicating the presence of cognitive impairment (Dick et al. 1984). Levels of impairment have also been classified as none (24–30); mild (18–24) and severe (0–17; Tombaugh & McIntyre 1992).
- The score of the 3MS ranges from 0–100 with a standardized cut-off point of <79 for the presence of cognitive impairment, and <48 for the presence of severe impairment. This expanded assessment takes approximately 5 minutes more to administer than the original MMSE.

Q4. What are the advantages of the Mini Mental State Examination?

- Only requiring 10 minutes to complete, the MMSE is brief, inexpensive and simple to administer.
- Its widespread use and accepted cut-off scores increase its interpretability.

Q5. What are the disadvantages of the Mini Mental State Examination?

- Suggested that the MMSE may attempt to assess too many functions in one brief test; an individual's performance on individual items or within a single domain may be more useful than interpretation of a single score (Tombaugh & McIntyre 1992; Wade 1992).
- MMSE scores have been shown to be affected by age, level of education and sociocultural background, which may lead to misclassification of individuals (Bleecker et al. 1988; Lorentz et al. 2002; Tombaugh & McIntyre 1992).
- Stroke literature reports low levels of sensitivity, particularly among individuals with mild cognitive impairment and patients with right-sided strokes (de Koning et al. 1998; Grace et al. 1995; Dick et al. 1984; Tombaugh & McIntyre 1992); the low level of sensitivity may be derived from the emphasis placed on language items and a paucity of visual-spatial items (de Koning et al. 1998; Grace et al. 1995; Suhr & Grace 1999).
- The MMSE has been thoroughly evaluated for use among a variety of neurological populations. Unfortunately, at present, information regarding the reliability and validity of the MMSE when used among patients with TBI/ABI is extremely limited.

Q6. Describe the benefit of adding the Clock-Drawing Test to the Mini Mental State Examination.

- Suggested solutions to the MMSE's poor sensitivity rates include the use of age-specific norms (Bleecker et al. 1988) and the addition of a clock-drawing task to the test (Suhr & Grace 1999).
- Clock-drawing tests themselves have been assessed as acceptable to patients, easily scored and

less affected by education, age and other non-dementia variables than other very brief measures of cognitive impairment (Lorentz et al. 2002) and would have little effect on the simplicity and accessibility of the test.

Table 20. The Mini-Mental State Examination

Maximum Score - 30	Testing Item
Orientation	
5	What is the date?
5	Where are we?
Registration	
3	Name three objects (1 second to say each) and then ask the patient to repeat all three after you have said them. Give one point for each correct answer. Continue repeating all three objects until the patient learns all three. Count trials and record.
Attention and Calculation	
5	Serial 7's. One point for each correct response. Stop after five answers. As an alternative, spell "world" backwards.
Recall	
3	Ask for the three objects named in Registration. Give 1 point for each correct answer.
Language	
2	Name a pencil and watch
1	Repeat the following "No ifs, ands, or buts"
3	Follow a three-stage command. "Take paper in your right hand, fold it in half, and put it on the floor."
1	Read and obey the following: CLOSE YOUR EYES
1	Write a sentence
1	Copy a design

Practicality

***Interpretability*:** The MMSE is widely used and has generally accepted cutoff scores indicative of the presence of cognitive impairment. Documented age and education effects have led to the development of stratified norms (Ruchinskas & Curyto 2003).
***Acceptability*:** The test is brief requiring approximately 10 minutes to complete. It may be affected by such patient variables as age, level of education and sociocultural background. As it is administered via direct observation of task completion, it is not suitable for use with a proxy respondent.
***Feasibility*:** The test requires no specialized equipment and little time, making it inexpensive and portable. A survey conducted by Lorentz et al. (2002) revealed participant physicians found the MMSE too lengthy and unlikely to contribute useful information.

Table 20. MMSE Evaluation Summary

Reliability		Validity		Responsiveness		
Rigor	Results	Rigor	Results	Rigor	Results	Floor/ceiling
+++	+++(TR) ++(IO) ++ (IC)	+++	++	N/A	N/A	N/A

NOTE: +++=Excellent; ++=Adequate; +=Poor; N/A=Insufficient Information; TR=Test Re-test; IC=Internal Consistency; IO=Interobserver.

Neurobehavioural Functioning Inventory

Q1. What does the Neurobehavioural Functioning Inventory test?

- The Neurobehavioural Functioning Inventory (NFI) was originally developed as part of the General Health and History Questionnaire, which was used to collect a variety of information on individuals who had experienced a TBI (Kreutzer et al. 1987).
- The NFI is intended to assess a wide spectrum of behaviours and symptoms encountered in everyday life in order to evaluate the neurological, behavioural and psychological effects of head injury (Kreutzer et al. 1996; Seel et al. 1997; Weinfurt et al. 1999).

Q2. Describe the Neurobehavioural Functioning Inventory.

- The NFI consists of 70 items representing behaviours or symptoms. These are grouped into six functional domains or subscales derived from principal components and factor analytic methodologies (Hart et al. 2003; Seel et al. 1997). The test contains forms for ratings by self and by a significant other. The test takes approximately 20 minutes to complete (Awad 2002).

Q3. Describe some of the key Neurobehavioural Functioning Inventory numbers.

- The six domains include depression (13 items), somatic (11 items), memory/attention (19 items), communication (10 items), aggression (nine items) and motor (eight items; Hart et al. 2003; Kreutzer 1999). Six additional, critical items relating to patient safety and community integration have been added to the scale (Kreutzer et al. 1999) to be used in the identification of areas requiring immediate attention (Awad 2002).
- Items are rated for frequency of occurrence on a 5-point Likert scale from 1 (never) to 5 (always). While the NFI is a self-rated inventory, it provides for the inclusion of information obtained from suitable proxy sources.

Q4. What are the advantages of the Neurobehavioural Functioning Inventory?

- NFI provides for the collection of information from collateral sources allowing for more comprehensive picture of both the difficulties experienced by the patient and the impact of problems on the home environment (Witol et al. 1999).
- Multiple sources of information can improve reliability of information provided through self-report from individuals with TBI who, due to impaired self-awareness, may supply unreliable information (Hart et al. 2003).

Q5. What are the disadvantages of the Neurobehavioural Functioning Inventory?

- No established construct validity for the NFI (Awad 2002); reasons may include poor fit indices, a large number of items with poor/weak relation to their latent construct (20 items with squared multiple correlation <0.40), strong correlations between subscales and an inability to distinguish a group of individuals with TBI from non-clinical controls.
- Weinfurt et al. (1999) reported very low endorsement rates for many of the items resulting in skewed distributions; low rates of endorsement might indicate that these items are not meaningful discriminators for the head injury population.
- Data is not truly normative; the data set used for standardization was derived from a population of individuals with TBI (there is no normative data available based on non-clinical populations; Awad 2002; Witol et al. 1999).
- Limited information regarding the scale's reliability, validity, and responsiveness; the information that is available pertains to older versions of the NFI and, at present, there is no validity or reliability data available for the 76-item version (Awad 2002).

Practicality

Interpretability: Comparative data are provided in the manual stratified by patient age and injury severity. The NFI has been translated into Spanish, German and French.
Acceptability: The NFI is a lengthy self-report inventory requiring approximately 20 minutes to complete. Forms are provided for assessment by self or by proxy.
Feasibility: The NFI is a proprietary scale and must be purchased.

Table 22. Neurobehavioural Functioning Inventory Executive Summary

Reliability		Validity		Responsiveness		
Rigor	**Results**	**Rigor**	**Results**	**Rigor**	**Results**	**Floor/ceiling**
+	**+++ (IC)**	**+**	**+**	**N/A**	**N/A**	**N/A**

NOTE: +++=Excellent; ++=Adequate; +=Poor; N/A=Insufficient Information; TR=Test Re-test; IC=Internal Consistency; IO=Interobserver.

Ranchos Los Amigos Levels of Cognitive Functioning Scale

Q1. What does the Ranchos Los Amigos Scale test?

- The RLA-LCFS provides a quick and simple description of global behaviour from which level of cognitive functioning is inferred. It focuses on the impact of cognitive dysfunction on arousal and overall behaviour, but does not provide information regarding specific domains of cognitive impairment (Labi et al. 1998).
- The RLA-LCFS was intended to provide a description of eight stages of cognitive function through which patients with brain injury typically progress during their stay in hospital and acute rehabilitative care (Hagen 1982; Hagen et al. 1972). It was not developed as a scale and is not considered to be an outcome measure. Rather, it is a global index used to describe awareness, environmental interaction and behavioural competence (Timmons et al. 1987; Zafonte et al. 1996). It is used to monitor recovery and classify outcome in patients with brain

injury (Gouvier et al. 1987).

Q2. Describe the Ranchos Los Amigos: Eight Levels of Cognitive Functioning.

- **I. No Response.** Patient appears to be in a deep sleep and is unresponsive to stimuli.
- **II. Generalized Response.** Patient reacts inconsistently and non-purposefully to stimuli in a nonspecific manner. Reflexes are limited and often the same, regardless of stimuli presented.
- **III. Localized Response.** Patient responses are specific but inconsistent, and are directly related to the type of stimulus presented, such as turning head toward a sound or focusing on a presented object. He/she may follow simple commands in an inconsistent and delayed manner.
- **IV. Confused-Agitated.** Patient is in a heightened state of activity and severely confused, disoriented, and unaware of present events. His/her behaviour is frequently bizarre and inappropriate to his/her immediate environment. He/she is unable to perform self-care. If not physically disabled, he/she may perform automatic motor activities such as sitting, reaching and walking as part of his/her agitated state, but not necessarily as a purposeful act.
- **V. Confused-Inappropriate, Non-Agitated.** Patient appears alert and responds to simple commands. More complex commands, however, produce responses that are non-purposeful and random. The patient may show some agitated behaviour in response to external stimuli rather than internal confusion. The patient is highly distractible and generally has difficulty in learning new information. He/she can manage self-care activities with assistance. His/her memory is impaired and verbalization is often inappropriate.
- **VI. Confused-Appropriate.**Patient shows goal-directed behaviour, but relies on cueing for direction. He/she can relearn old skills such as activities of daily living, but memory problems interfere with new learning. He/she is beginning to demonstrate awareness of self and others.
- **VII. Automatic-Appropriate.** Patient goes through daily routine automatically, but is robot-like with appropriate behaviour and minimal confusion. He/she has a shallow recall of activities and a superficial awareness of, but lack of insight into, his/her condition. He/she requires at least minimal supervision because judgment, problem solving, and planning skills are impaired.
- **VIII. Purposeful-Appropriate.** Patient is alert and oriented, and is able to recall and integrate past and recent events. He/she can learn new activities and continue in to improve with respect to home and living skills, though deficits in stress tolerance, judgment, abstract reasoning, social, emotional, and intellectual capacities may persist.

Q3. What are the advantages of the Ranchos Los Amigos Scale?

- Provides a quick and simple snapshot of level of recovery.
- Useful for making quick comparisons between groups (Johnston & Lewis 1991).
- Simplicity and utility have resulted in widespread use within the United States (Hall 1997; Hall & Johnston 1994).

Q4. What are the disadvantages of the Ranchos Los Amigos Scale?

- Lack of standardization, which effects inter-observer reliability.

Table 23. Rancho Los Amigos Levels of Cognitive Functioning

Level	Clinical Presentation	Function
I	No Response	Total Assistance
II	Generalized Response	Total Assistance

III	Localized Response	Total Assistance
IV	Confused/Agitated	Maximal Assistance
V	Confused, Inappropriate Non-Agitated	Maximal Assistance
VI	Confused, Appropriate	Moderate Assistance
VII	Automatic, Appropriate	Minimal Assistance for Daily Living Skills
VIII	Purposeful, Appropriate	Stand-By Assistance
IX	Purposeful, Appropriate	Stand-By Assistance on Request
X	Purposeful-Appropriate	Modified Independent

(Hagen et al. 1972; Hagen et al. 1998)
Note: Levels IX and X were included in the revised Rancho Scale (Hagen 1998).

Practicality

***Interpretability*:** The RLA-LCFS is used widely in the United States and provides a quick, global picture of level of recovery.
***Acceptability*:** Ratings are derived from observation and result in little or no patient burden. Use of collateral information to derive ratings has not been evaluated.
***Feasibility*:** The RLA-LCFS is short and simple. It is available free of charge. The LCFS has been evaluated for use in longitudinal assessments.

Table 24. Rancho Los Amigos Levels of Cognitive Functioning Evaluation Summary

Reliability		Validity		Responsiveness		
Rigor	**Results**	**Rigor**	**Results**	**Rigor**	**Results**	**Floor/ceiling**
+	**+++(TR) +++(IO)**	**+**	**+++**	**+**	**+ (p-values only)**	**N/A**

NOTE: +++=Excellent; ++=Adequate; +=Poor; N/A=Insufficient Information; TR=Test Re-test; IC=Internal Consistency; IO=Interobserver.

Satisfaction with Life Scale

Q1. What does the Satisfaction with Life Scale test?

- Life satisfaction may be defined as a conscious, cognitive, global judgment of one's own life. It is not an assessment based on externally imposed objective standards, but rather depends upon a comparison of one's life circumstances to one's own internal standards or criteria (Diener et al. 1985; Pavot et al. 1991, 1998).
- The Satisfaction with Life Scale (SWLS) was created to assess a person's global judgment of life satisfaction (Diener et al. 1985).

Q2. Describe the Satisfaction with Life Scale.

- Diener et al. (1985) generated 48 self-report items related to satisfaction with life, including items assessing positive and negative affect. Factor analyses were used to identify three factors; life satisfaction, negative affect and positive affect.
- All affect items were eliminated as were items with factor loadings of less than 0.60. The remaining 10 items were reduced to five on the basis of "semantic similarity" (Diener et al.

1985).

Q3. Describe some of the key Satisfaction with Life Scale numbers.

- It has been suggested that a score of 20 is regarded as neutral, while scores in excess of 20 represent satisfaction (21–25=slightly satisfied; 26–30=satisfied), and scores of less than 20 represent dissatisfaction (15–19=slightly dissatisfied; 5–9=extremely dissatisfied; Pavot & Diener 1993).

Q4. What are the advantages of the Satisfaction with Life Scale?

- Freely available, simple, and quick to administer and score.
- Can be used in populations of varying ages (adolescent, young adult, and senior; Diener et al. 1985).
- Available in several languages including Spanish, French, Russian, Korean, Hebrew, Mandarin Chinese, Portuguese, Dutch, and Taiwanese.

Q5. What are the disadvantages of the Satisfaction with Life Scale?

- No studies specifically evaluating the use of this scale within the adult ABI population have been identified.
- Interpretation of scores is not clear.
- One cannot assume that SWLS scores provide a direct assessment of emotional well-being.
- No published normative data for the SWLS exist.
- While some findings suggest that SWLS is not affected by gender or age (Pavot & Diener 1993; Shevlin et al. 1998; Wu & Yao 2006; Westaway et al. 2003), some studies have reported that SWLS scores were related to employment status and level of education (Westaway et al. 2003), as well as gender and socioeconomic status (Neto 1993).

Table 25. Satisfaction with Life Scale

Example statements from the Satisfaction with Life Scale:

- In most ways my life is close to my ideal
- The conditions of my life are excellent
- I am satisfied with my life
- So far I have gotten the important things I want in life
- If I could live my life over, I would change almost nothing

(Woo & Nesathurai 2000)

Respondents are instructed to rate each item using a 7-point scale ranging from 1 (strongly disagree) to 7 (strongly agree). Item ratings are summed to provide a total score ranging from 5–35 where higher scores are indicative of greater life satisfaction. The SWLS takes a global approach to assessment. Because no specific domains are named within the scale and items are not specific in nature, the respondent remains free to consider the life domains or affective components he or she feels make the most important contribution to their subjective experience of happiness (Arrindell et al. 1999; Diener et al. 1985; Pavot & Diener 1993). The scale is short and simple to administer and score. It can easily be added to assessments using multiple measures with no significant increase in time (Pavot et al. 1991).

Practicality

***Interpretability*:** Guidelines for absolute interpretation of scores are available. To our knowledge, no normative data is presently available for the SWLS.
***Acceptability*:** Scale items are at a suitable reading level for most adults and it takes a minimal amount of time for the subject to complete the measure in its entirety.
***Feasibility*:** Brief, simple, and low-cost administration.

Table 26. Satisfaction with Life Scale Evaluation Summary

Reliability		Validity		Responsiveness		
Rigor	**Results**	**Rigor**	**Results**	**Rigor**	**Results**	**Floor/ceiling**
+++	**++(TR) +++ (IC)**	**++**	**+++**	**+**	**+**	**N/A**

NOTE: +++=Excellent; ++=Adequate; +=Poor; N/A=Insufficient Information; TR=Test Re-test; IC=Internal Consistency; IO=Interobserver.

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