Outcome Instruments in Moderate-to-Severe Adult Traumatic Brain Injury:

Recommendations for use in Psychosocial Research

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Abstract

Background: Traumatic brain injury (TBI) can reduce psychosocial functioning, causing relationship, family, and employment difficulties. The present study by Moving Ahead: Centre for Research Excellence (CRE) in Brain Recovery (McDonald et al., 2012), aimed to identify a set of adult outcome instruments for moderate-to-severe TBI psychosocial research.

Procedure: A review of 115 instruments (identified through nomination, literature search, international expert opinion) was conducted over a 15-month period. Eleven psychosocial areas were examined: Global Outcome, Communication, Social Cognition, Behavioural and Executive Function, Other Neuropsychological Functioning, Psychological Status, TBI-related Symptoms, Activities and Participation, Support and Relationships, Sense of Self, and Health-related Quality of Life. Individual instruments were considered against *selection guidelines*, and specific measures that best met the guidelines were identified as core (common across all studies), supplemental (dependent on study type) or emerging.

Results: The final recommendations, organised in accordance with the World Health Organisation's International Classification of Functioning taxonomy, comprised 56 instruments for use in early recovery, outcome, and intervention studies.

Conclusion: These recommendations provide a coherent framework along with identified outcome instruments to guide psychosocial research in moderate-to-severe TBI. Adherence to the recommendations will enable data-pooling and comparison across studies and research settings facilitating consistent measurement across the lifespan.

Keywords: traumatic brain injury, psychosocial, outcome assessment, remediation, research, recommendations

Traumatic brain injury (TBI) often leads to detrimental changes to emotional, behavioural, and social aspects of a person's functioning (known otherwise as psychosocial functioning), resulting in difficulties maintaining relationships, increased stress within the family, reduced community participation and difficulties in maintaining and gaining employment (Andelic et al., 2016; Kersel, Marsh, Havill, & Sleigh, 2001; Ponsford, Olver, Curran, & Ng, 1995; Tate, Broe, Cameron, Hodgkinson, & Soo, 2005). This, in turn, leads to social isolation and a significantly reduced quality of life (Forslund, Roe, Sigurdardottir, & Andelic, 2013; Ponsford et al., 2014). Consequently, rehabilitation to improve psychosocial functioning is of paramount importance. However, the effectiveness of many available treatments is questionable. For instance, despite substantial evidence for cognitive rehabilitation following TBI, there is limited evidence that this leads to improvements in everyday functioning, participation, and life satisfaction (Cicerone et al., 2011). Evidence for existing psychosocial rehabilitation, particularly interventions targeting social reintegration, is also limited (Cullen, Chundamala, Bayley, & Jutai, 2007; McCabe et al., 2007). In recognition of this, the Australian National Health and Medical Research Council's (NHMRC) 'Moving Ahead' Centre of Research Excellence (CRE) in Brain Recovery was established. This centre takes a multidisciplinary, multisite approach to addressing psychosocial rehabilitation of individuals following TBI (for a summary of the CRE aims see McDonald et al., 2012).

One aim of the CRE was to develop a coherent framework within which to guide the activities of researchers addressing psychosocial functioning and remediation following TBI (McDonald et al., 2012). Part of this framework involves recommending outcome instruments for psychosocial research, more specifically: (1) assisting researchers with the selection of appropriate instruments for the type of study being conducted, and (2) aligning the research activities across TBI research centres and across disciplines (e.g., speech pathology, occupational therapy, clinical psychology, social work, neuropsychiatry and neuropsychology). A major benefit of these recommendations is increased cross-centre collaboration and data-pooling, which in turn will improve the quality and compatibility of research into psychosocial functioning following TBI.

In 2010, the United States (US) Interagency Common Data Elements (CDE) project proposed a set of outcome measure recommendations for adult TBI research. While the primary aims of these recommendations were to promote the use of robust, cost-effective instruments and to harmonise outcomes, they were also designed to document the natural course of recovery from TBI, predict later outcomes, measure treatment effects, and compare outcomes across studies, (Wilde et al., 2010). An updated version of the TBI CDEs (v.2) was developed in 2012 and is available for download from https://commondataelements.ninds.nih.gov/tbi.aspx. The development of these recommendations represented a vital step forward for TBI researchers. The current recommendations expand on the existing US CDE recommendations in several ways. First, they address the conduct of psychosocial research and align use of outcome instruments across the lifespan. Second, they classify the instruments according to the taxonomy of the International Classification of Functioning, Disability and Health (ICF; World Health Organisation (WHO), 2001) and are consistent with the identified ICF core sets for persons with TBI (Bernabeu et al., 2009; Bickenback, Cieza, Rauch, & Stucki, 2012). Finally, they provide an indication of sensitivity to change for the instruments. Each of these features is discussed briefly below.

Recommendations for psychosocial research. A moderate-to-severe TBI may result in deficits in cognitive, emotional, and physical function, each of which interact to significantly reduce independence. However, it is often the *changes* in a person's level of psychosocial functioning that are considered most disruptive to employment and family and social relationships, and which contributes to social isolation and withdrawal (Forslund et al., 2013; Ponsford et al., 2014; Ponsford et al., 1995; Tate et al., 2005). Given these detrimental outcomes, psychosocial difficulties are often a primary target for rehabilitation. Not surprisingly, the effectiveness of psychosocial interventions and understanding factors that influence outcomes and the rehabilitation process is the focus of much TBI research. However, despite good evidence of the effectiveness of isolated interventions (e.g., to improve cognitive functioning; Cicerone et al., 2011), the quality and quantity of evidence of various interventions aiming to improve psychosocial outcomes is incomplete and patchy (McDonald

et al., 2012). For example, social cognition in TBI is an emerging area and evidence for the effectiveness of social-cognitive interventions is still being accumulated. Theories describing the processes of rehabilitation are also lacking (Whyte & Hart, 2003). These limitations are concerning given the need for clinicians to provide high standards of patient care, which can only be achieved with evidence-based decision making about rehabilitative practices (Carter & Lubinsky, 2015). Consequently, a coherent framework to guide future psychosocial research activities is needed (McDonald et al., 2012). Providing recommendations on the use of outcome measures for use in 'psychosocial research' is core to this framework.

Measurement across the lifespan. A critical factor in psychosocial TBI research is the way in which outcomes may be affected, not only by injury severity, time since injury, and/or the social context, but also by the age or critical developmental stage at which the injury occurred and the age/stage when the outcome was measured (Anderson, Northam, Hendy & Wrennall, 2001). For example, family functioning contributes significantly to long-term outcomes following injury and is particularly relevant for the young child who is strongly influenced by the family context (Anderson, Catroppa et al., 2001; Yeates et al., 2004; Yeates et al., 2002). Accordingly, psychosocial TBI research involves both the examination of outcomes at various developmental stages, and how this changes over time and in response to rehabilitation. Essential to this examination is consistent measurement throughout the lifespan. In keeping with the US CDE project, the current recommendations were developed with measurement across the lifespan in mind. The current paper focuses on instruments for the adult age group and a companion paper details instruments for the paediatric population. The two projects were conducted in tandem; outcome instruments applicable across the lifespan are uncommon, but have obvious advantages.

The ICF Framework. The current set of recommendations are organised using the taxonomy of the ICF (WHO, 2001). This classification system aims to "provide a unified and standard language and framework for the description of health and health-related states" (WHO, 2001, p.3). This system recognises that a person's level of functioning may be assessed from a variety of

perspectives. Given the inherent interaction among multiple factors, an assessment from all perspectives is required to achieve best practice (Tate, 2010). The ICF contains a nested, hierarchical structure comprising parts, components, domains (the first classification level), and categories (the second, third and fourth classification levels). Part 1 deals with functioning and disability while Part 2 covers contextual factors (see Figure 1 for diagrammatical representation). Of most relevance to psychosocial research are the "Mental Functions" domain (nested within the component "Body Functions" in Part 1), the "Activities/Participation" component (also nested in Part 1), and the "Support and Relationships" and "Attitudes" domains (nested within the component "Environmental Factors" in Part 2).

[INSERT FIGURE 1 ABOUT HERE]

There are benefits to adopting the ICF Framework for psychosocial research (WHO, 2013). It is based upon a biopsychosocial model that fits well with our focus on psychosocial function. The ICF provides a common language of terms and concepts for use by, not only TBI researchers, but also people who provide rehabilitation services and the person who is experiencing the disability. Given that individuals with TBI interact with clinicians, communication using a common language may lead to more efficient processes and improved integrated care. Second, the ICF provides a structure for the organisation of data, and this, in turn, can inform information systems for policy development and health services related to TBI. Collating research data within the ICF model and framework will also contribute to a coherent international understanding of disability and functioning associated with TBI and allow data to be compared across settings and time. Finally, the ICF is a multi-purpose tool which can be used in a variety of ways. It may be viewed as 'meta-language to help clarify the relationship between data, information and knowledge, and to build a shared understanding and interpretation of concepts' (WHO, 2013, p.10). This, in turn, helps to ensure consistency of application across various sectors and levels of health, social and education systems.

Responsiveness. Whether an instrument is sensitive to change in individuals with TBI is highly relevant to psychosocial research. Responsiveness in the context of psychosocial outcomes

requires consideration of a measure's ability to assess change in response to recovery following insult and/or following treatment. This change must reflect "real" change in functioning as opposed to measurement error. The current recommendations specify whether each measure used to assess psychosocial outcomes has evidence in the published literature that it is sensitive to change. This will enable the researcher to make further judgements about an instrument's usefulness for specific research questions.

Context of studies. Outcomes following TBI may differ according to injury severity. People with moderate-to-severe injuries, in particular, experience unique challenges to their social environment. Notably, they experience poorer outcomes (both in terms of mortality and morbidity) than those with mild TBI and are consequently much more likely to require rehabilitation both acutely and post-acutely (Roebuck-Spencer & Sherer, 2011). Outcomes following mild TBI, on the other hand, are often controversial. For example, Belanger, Curtiss, Demery, Lebowitz and Vanderploeg (2005) found in their meta-analysis of cognitive deficits following mild TBI, that moderate effect sizes in cognitive deficits are only demonstrated acutely, within the first three-months post-insult. Given the possible differences between moderate-to-severe versus mild TBI injuries, and the increased likelihood of those with more severe injuries requiring psychosocial rehabilitation, the current paper is focused on providing recommendations for the use of outcome instruments in studies involving individuals with moderate-to-severe TBI.

Moving Ahead CRE Outcome Measure Working Group

The Moving Ahead CRE Outcome Measure Working Group comprised 12 researchers from research institutions across Australia, all of whom have substantial expertise in assessing and researching psychosocial outcomes following TBI. The working group included speech pathology, occupational therapy, clinical psychology, and clinical neuropsychology. Two project managers were appointed to ensure milestones were achieved within the specified timeframes and adherence to the original aims and purpose of the project.

Method

Steps involved in the outcome instrument selection process are shown in Figure 2 and outlined below.

[INSERT FIGURE 2 ABOUT HERE]

Psychosocial Area Selection

Based on the collective experience of the working group, 11 functional outcome areas were identified as most relevant to psychosocial research in TBI. The steps to identify these areas were as follows. (1) 'Domains' already devised by the US-based CDE TBI workgroup outcome measure recommendation (see https://commondataelements.ninds.nih.gov/tbi.aspx) were systematically evaluated at several working group meetings. Consistent with the CRE's aim of extending on the US CDE recommendations and to more accurately reflect the activities of psychosocial researchers, the working group discussed each domain and made a judgement as to their appropriateness for psychosocial research. The retained US CDE domains were deemed relevant to psychosocial research. (2) Where appropriate, domain names were adjusted (e.g., Social Role Participation and Social Competence was changed to Activities and Participation) or a definitions altered (e.g., Communication) to be more reflective and descriptive of psychosocial research and/or ICF categorisation. (3) A new domain was included to reflect the various components of 'the self' that are commonly assessed in psychosocial research (Sense of Self). While the terms *area* and *domain* are synonymous, the former term is hereon used to avoid confusion with ICF domains in the current recommendations. The agreed psychosocial areas included: (1) Global Outcome, which includes concepts related to several ICF domains; (2) Communication, (3) Social Cognition, (4) Behavioural and Executive Function, (5) Other Neuropsychological Functioning Instruments, (6) Psychological Status, and (7) TBI-Related Symptoms, which cover concepts most closely aligned with the ICF Body Functions (b) domain and Mental Functions component (b1); (8) Activities and Participation, which covers concepts most closely aligned with the ICF Activities/Participation (d) domain; (9) Support and Relationships, which covers a concept most closely aligned with the ICF Environmental Factors

(e) domain; (10) Sense of Self, which covers concepts most closely aligned with the ICF Personal Factors domain (yet to be classified); and (11) Health-Related Quality of Life (QoL), a concept which is not currently covered in the ICF. While some of these domains do not reflect psychosocial outcomes per se, they reflect areas of critical impairment or status that may directly impact psychosocial functioning in TBI (e.g., Other Neuropsychological Functioning, Psychological Status) and thus were included in the recommendations. These psychosocial areas are also intended to be non-discipline specific. For instance, communication instruments are not intended for use only by speech pathology researchers. Descriptions of the psychosocial areas are provided in Table 1.

[INSERT TABLE 1 ABOUT HERE]

Approach to ICF Classification. ICF classification proceeded in accordance with the 'construct intent' approach outlined by Tate, Godbee, and Sigmundsdottir (2013). Unlike a 'linking' approach which links each item of an instrument to ICF categories (e.g., Cieza, et al., 2002; Laxe et al., 2012), the construct intent approach takes into account the intended purpose of the instrument. As highlighted by Tate et al., the linking approach can be problematic given that meaningful constructs are applied to the individual items of the instrument and may overlook the intent behind the instrument's development. For example, the Glasgow Coma Scale (GCS) assesses consciousness, a construct defined in ICF as code b110. However, the three items of the instrument (eye opening, motor response and verbal response) are not individually identifiable as being linked to the consciousness construct in the ICF (Tate et al. 2013). In the present study, both psychosocial areas and instruments were classified in the domain/category of best fit. 'Multi-category', 'multi-domain' or 'multi-dimensional' instruments were assigned several ICF codes (these are detailed in Tables 3a-3k). Depending on the specificity of the measure, either a first, second, third or fourth classification level was applied. For example, whereas the Care and Needs Scale (CANS; a general measure of support) was classified at the first (domain) ICF level (e3 Support and Relationships, nested in e Environmental Factors), the Self Awareness of Deficits Interview (SADI; a specific measure of patient self-awareness) was classified at the third (category) ICF level (b1644 Insight, nested in b164 Higher

Level Cognitive Functions, b1 Mental Functions, and b Body Functions). An independent researcher familiar with the ICF taxonomy conducted a final review of the ICF classifications applied to the recommended instruments. A full listing of the ICF classification codes may be obtained from WHO ICF webpage: http://www.who.int/classifications/icf/en/.

Initial Psychosocial Outcome Measure Selection

Following psychosocial area selection, the working group nominated instruments for inclusion in each area. An initial list 86 instruments were devised through this process. For each instrument a "brief" was prepared describing basic features and purpose, whether self or other-report, clinician rated instrument/scale or objective measure, psychometric properties (specific to TBI), strengths and weaknesses and ICF code/s. For instruments directly assessing psychosocial outcomes, a specification was made regarding sensitivity to change based on empirical evidence. Instruments measuring neuropsychological constructs which are not typically the target of psychosocial remediation and screening instruments assessing drug and alcohol misuse were not assessed for sensitivity to change.

Initial recommendations were also made about the instrument's suitability for three *types* of research: *Early recovery* studies (up to approximately 3 months post injury), usually when the individual is an inpatient; *Intervention* studies, examining the effectiveness of intervention; *Outcome* studies examining post-acute psychosocial functioning. Consistent with the TBI CDE v.2, instruments were considered for four tiers of recommendations: *Core* instruments, i.e. well established instruments relevant to all TBI psychosocial study types and applicable to all moderate-to-severe TBI patient groups over the entire treatment spectrum, thus recommended for consistent use in all studies; *Basic* instruments: similar to core instruments, but only recommended for consistent use in a particular study type; *Supplemental* instruments: measures that are recommended depending on the particular aims of a study; *Emerging* instruments: measures under development which may yet prove to be psychometrically superior to currently available instruments and/or assess constructs not currently possible to assess with available instruments.

Subsequent steps in the recommendation process

Following (1) domain selection, (2) identification of an initial list of instruments and (3) brief preparation, the following steps were taken; (4) an anonymous survey asked the working group about frequency of use of the nominated instruments on a 4-point Likert type scale from 'Never' to 'Always'; (5) 1-2 reviewers from the working group with relevant expertise undertook a review of all nominated instruments in a given psychosocial area according to a range of *guidelines* (see Table 2). These were largely consistent with the 'selection criteria' used by the US-based TBI CDE process. Additional guidelines beyond the US-based TBI CDE process included: wide use in psychosocial research, availability of international normative data and flexibility of formats (e.g., self- and proxy-reports for questionnaires). Consistent with the overall aims of this project, the outcome instruments were also assessed based on their capacity to document the natural course of recovery and ability to measure treatment effects (i.e., responsiveness), enhance the prediction of later outcomes, and facilitate comparisons across studies. Given adherence to all guidelines was not possible, instrument selection was determined through detailed evaluations of their pros and cons.

[INSERT TABLE 2 ABOUT HERE]

(6) Reviewers also identified gaps in coverage of psychosocial function by the nominated instruments, sourced additional instruments from the literature, and prepared briefs for them. Instruments were sourced from the literature by searching for related keywords (e.g., social cognition, emotion perception, theory of mind, empathy) in key psychology-related databases including PubMed, PsycINFO and Embase. Additional keywords related to TBI and similar patient groups were also searched (e.g. traumatic brain injury, head injury, stroke). An additional 24 instruments were included in the review from this search.

(7) Working group members met monthly via teleconference over a 15-month period to discuss instruments and develop a list of recommendations. Each meeting discussed all instruments in a particular psychosocial area, facilitated by the nominated reviewer/s. The merits of each instrument against the guidelines were discussed, with recommendations made regarding suitability

for study types, the level of recommendation (core, basic, supplemental, emerging), and whether the instrument was sensitive to change. While disagreements were few, they were resolved using a Delphi-style communication technique. This involved firstly discussing the strengths and weaknesses of the instruments (with reference to the specified guidelines in Table 2) over at least two meetings. A summary of the arguments, including expert advisory comments (see below), were then presented to working group members who then completed an anonymous survey and poll (this occurred with the DASS vs. HADS, and 8-GOS vs GOSE as a Core instrument). (8) A full-day workshop was held to review and fine-tune the entire list of recommendations.

(9) An international Expert Advisory Board (EAB), consisting of nine internationally renowned experts in areas consistent with the psychosocial areas from the United Kingdom, Netherlands, and United States of America was established with one-to-two EAB reviewers per psychosocial area. The EAB reviewed the recommendations and provided feedback through written reports. An additional five instruments were considered for inclusion through this process (totalling 115 instruments considered for inclusion in the recommendations). This feedback and additional instrument nominations were discussed at two final face-to-face meeting of the working group. (10) A final list of recommendations with ICF codes was then endorsed by the working group members.

The full list of instruments reviewed (note that some instruments were considered for inclusion in more than one psychosocial area) included 11 Global Outcome instruments. Within the ICF Body Functions/Mental Functions (d1) domain/component, 19 Communication, five Social Cognition, six Behavioural and Executive Function, 24 Other Neuropsychological Functioning, 20 Psychological Status, and five TBI-Related Symptoms instruments were considered. Within the ICF Activities/Participation (d) and Environmental Factors (e) domains, 13 Activities and Participation and eight Support and Relationships instruments, respectively, were considered. Within the ICF Personal Factors domain (yet to be classified in the framework), 15 Sense of Self instruments were considered. Finally, six Health-Related Quality of Life instruments, a concept not covered by the

current ICF, were considered. A listing of instruments considered for inclusion in each psychosocial area are contained in the Supplemental document.

Results

Recommendations for TBI Outcome Measures

The recommended instruments are summarised in Table 3 grouped by psychosocial area and ICF domain (see Supplemental document for extended Tables s1a to s1k that include basic psychometric property information and a summary of instrument strengths and weaknesses). The tables describe the level of recommendation (core, basic, supplemental, emerging), type of study (early recovery, intervention, outcome) for which the recommendation is made, basic information on psychometric properties including responsiveness, and strengths and weaknesses. In total, 56 instruments were recommended. Full briefs containing a description of the instrument, administration procedures, population and age-range use, and psychometric properties can be downloaded from the CRE website (www.moving-ahead.com.au). A short description of the content of the recommended instruments is provided in the supplemental material that attaches to this publication.

[INSERT TABLE 3 HERE]

Multiple ICF Components

Three rating scales measuring outcome in global terms were recommended. The Glasgow Outcomes Scale-Extended (GOS-E; Teasdale, Pettigrew, Wilson, Murray, & Jennett, 1998) was recommended as Core for all study types. The Glasgow Outcome Scale at Discharge (GODS; McMillan, Weir, Ireland, & Stewart, 2013) may be substituted for the GOS-E where appropriate for hospitalised patients. The Mayo-Portland Adaptability Inventory (MPAI-4; Malec & Lezak, 2008) and the Health of the Nation Outcome Scales for Acquired Brain Impairment (HoNOS-ABI; Coetzer & Du Toit, 2001) were recommended as Supplemental for all study types in this area.

Body Functions (b): Mental Functions (b1)

Communication

Eight instruments recommended in the Communication area were recommended, a number of which address communication more broadly, as well as verbal aspects of executive functions. The Western Aphasia Battery-Revised (WAB-R; Kertesz, 2007), Frenchay Dysarthria Assessment-2 Edition (FDA-2; Enderby & Palmer, 2008), Boston Naming Test Second Edition Short Form (BNT-S; Kaplan, Goodglass, Weintraub, & Segal, 1983), Adapted Kagan Scales for TBI Interactions (Kagan et al., 2004), Profile of Pragmatic Impairment in Communication (PPIC; Hays, Niven, Godfrey, & Linscott, 2004), Discourse Tasks (Coelho, Ylvisaker, & Turkstra, 2005) from the TBI Bank Protocol (http://www.talkbank.org/tbibank/) and the Latrobe Communication Questionnaire (LCQ; Douglas, O'Flaherty, & Snow, 2000) were recommended as Supplemental for all study types in this area. An exception is the Functional Assessment of Verbal Reasoning and Executive Strategies (FAVRES; MacDonald & Johnson, 2005), which was recommended only for Intervention and Outcome studies as Supplemental.

Social Cognition

Two instruments for the Social Cognition area were recommended. The Awareness of Social Inference Test (TASIT; McDonald, Flanagan, Rollins, & Kinch, 2003) or its short form TASIT-S (Honan, McDonald, Sufani, Hine, & Kumfor, 2016) and the Interpersonal Reactivity Index (IRI; Davis, 1980; 1983) were recommended as Supplemental for all study types in this area.

Behavioural and Executive Function

Three rating scales recommended for the Behavioural and Executive Function area were recommended. This includes the Overt Behaviour Scale (OBS; Kelly, Todd, Simpson, Kremer, & Martin, 2006), Dysexecutive Questionnaire (DEX; Burgess et al., 1996), and Behaviour Rating Inventory of Executive Function – Adult (BRIEF-A; Roth, Isquith, & Gioia, 2005). All instruments were recommended as Supplemental for all study types in this area. A number of performance-based instruments evaluating verbal aspects of executive function are grouped in the preceding section on Communication.

Other Neuropsychological Functioning

A selection of seven instruments evaluating other neuropsychological functions pertinent to psychosocial research after TBI: premorbid cognitive level, working memory and processing speed, verbal memory, language processing and aspects of executive function (see also the area of communication which also contains executive function instruments) were recommended. They include the Shipley-2 (Shipley, Gruber, Martin, & Klein, 2009), the Digit Span subtest and Processing Speed Index (PSI) from the Wechsler Adult Intelligence Scale–IV (WAIS-IV; Wechsler, 2008), Logical Memory from the Wechsler Memory Scale-IV (WMS-IV; Wechsler, Holdnack, & Drozdick 2009), the Rey Auditory Verbal Learning Test (RAVLT; Rey, 1964; Schmidt, 1996), the Trail Making Test (TMT; described in Lezak et al., 2012), and verbal fluency tasks including the Controlled Oral Word Association Test (COWAT; Benton & Hamsher, 1976; Spreen & Strauss, 1988) and Animal Naming (Spreen & Strauss, 1998). All instruments were recommended as Supplemental for all study types.

Psychological Status

Seven self-report rating scales were recommended for the Psychological Status area. All scales were recommended as Supplemental for all study types in this area. They include the Alcohol Use Disorders Identification Test (AUDIT*;* Saunders, Aasland, Babor, Fuente, & Grant, 1993), Drug Abuse Screening Test (DAST; Gavin, Ross, & Skinner, 1989), Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983), Beck Hopelessness Scale (BHS; Beck, Weisman, Lester & Trexler, 1974), Beck Scale for Suicide Ideation (BSS; Beck, Kovacs & Weissman, 1979), Brain Injury Questionnaire on Sexuality (BIQS; Ponsford, 2003), and Impact of Event Scale - Revised (IES-R; Weiss & Marmar, 1996).

TBI-Related Symptoms

Four instruments evaluating sleep and fatigue were recommended for the TBI-Related Symptoms area. They include the Epworth Sleepiness Scale (ESS; Johns, 1991), Pittsburgh Sleep Quality Index (PSQI; Fictenberg, Putnam, Mann, Zafonte, & Millard, 2001), Fatigue Severity Scale (FSS; Krupp, LaRocca, Muir-Nash, & Steinberg, 1989), and Modified Fatigue Impact Scale (MFIS; Tellez et al., 2005). The MPAI-4, described in the Global Outcomes area also contains items beyond

sleep and fatigue pertinent to this area. All instruments were recommended as Supplemental for all study types in this area.

Activities/Participation (d)

Activities and Participation

Six rating scales recommended for the Activities and Participation area were recommended. The Sydney Psychosocial Reintegration Scale (SPRS-2; Tate, 2011), Dyadic Adjustment Scale (DAS; Spanier, 1976), Nottingham Leisure Questionnaire (NLQ; Drummond & Walker, 1994) and Canadian Occupational Performance Measure (COPM*;* Law et al., 2014) were recommended as Supplemental instruments for all study types in this area. The Craig Handicap Assessment and Reporting Technique (CHART; Mellick, Walker, Brooks, & Whiteneck, 1999) was recommended as a Supplemental instrument for use only in Intervention and Outcome studies. The World Health Organisation Disability Assessment Schedule 2.0 (WHODAS 2.0; WHO, 2004) was recommended as an emerging instrument.

Environmental Factors (e)

Support and Relationships

Five rating scales were recommended for the Support and Relationships area. They include the Caregiver Strain Index (CSI*;* Robinson, 1983), Family Assessment Device (FAD; Miller, Bishop, Epstein, & Keitner, 1985), Lubben Social Network Scale-Revised (LSNS-R; Lubben & Gironda, 2004), Social Support Survey (SSS; Sherbourne & Stewart, 1991), and Care and Needs Scale (CANS; Tate, 2004). All instruments were recommended as Supplemental for all study types in this area.

Personal Factors

Sense of Self

Seven instruments were recommended for the Sense of Self area. Instruments recommended as Supplemental for all study types in this area include the Self-Awareness of Deficits Interview (SADI*;* Fleming, Strong, & Ashton, 1996), Patient Competency Rating Scale (PCRS; Prigatano et al., 1986), Head Injury Semantic Differential Scale - III (HISDS-III*;* Carroll & Coetzer,

2011), and Rosenberg Self-Esteem Scale (RSES; Rosenberg, 1965). The Motivation for Traumatic Brain Injury Rehabilitation Questionnaire (MOT-Q*;* Chervinsky et al., 1998) and Tennessee Self-Concept Scale-2 (TSCS-2; Fitts & Warren, 1997) were recommended as Supplemental instruments for use in Intervention studies only. The BIRT Motivation Questionnaire (BMQ*;* Oddy, Cattran, & Wood, 2008) was identified as an Emerging instrument. The DEX noted in the above section of Behavioural and Executive Function is also regarded as a measure of awareness, and thus may also be used as an indicator of the extent of awareness of executive dysfunction.

Concepts Not Covered By ICF

Health-Related Quality of Life

Four rating scales were recommended for the Heath-Related Quality of Life area. All instruments were recommended as Supplemental for all study types. They include the EuroQol-5 Dimensions (EQ-5D; EUROQOL Group, 1990), Satisfaction with Life Scale (SWLS; Diener, Emmons, Larsen, & Griffin, 1985), World Health Organisation Quality of Life BREF (WHOQOL-BREF; WHOQOL Group, 1998), and Traumatic Brain Injury Quality of Life (TBI-QoL; Tulsky et al., 2016) questionnaires.

Discussion

This paper details recommendations for the use of outcome instruments in TBI psychosocial research. The intention is not to detail a prescriptive list of instruments that must be included in a study. It is recognised that the recommendations may not suit all psychosocial studies conducted, particularly if a highly focused area is being examined. Researchers should be mindful of the purpose of their study and incorporate the current recommendations where they feel it is appropriate. These recommendations are also not intended to replace, but rather complement the US-based CDE recommendations, by providing additional guidance for those conducting psychosocial studies in moderate-to-severe TBI. This additional guidance encompasses the conduct of psychosocial research and aligns use of outcome instruments across the lifespan, classification of the instruments according to the taxonomy of ICF, and indication of sensitivity to change for the instruments. While these recommendations have been organised to reflect the ICF taxonomy, the recommendations are

not intended to comprehensively evaluate TBI according to this taxonomy. There may thus be ICF categories not reflected in the current recommendations, and as previously noted, recommendations are provided for health-related quality of life, a concept not covered by the ICF.

Although guidelines were used (i.e., Table 2) to evaluate the instruments, adherence to all guidelines was simply not possible for most recommended instruments. Each instrument was selected by weighing up its strengths and weaknesses. For example, in choosing the WAIS-IV consideration was given to its prior recommendations for use by the US TBI CDE Workgroup, its excellent psychometric properties and high level of use. It was agreed that these strengths outweighed the tool's low accessibility due to high cost and use limited to trained professionals. The appropriateness of psychosocial outcome instruments is also dynamic. Over time, new instruments will be developed and existing instruments may become outdated. Accordingly, it is important that the current recommendations be reviewed every few years and updated as appropriate.

The current recommendations were made specifically for people with moderate-to-severe TBI. Recommendations for mild TBI were not provided primarily due to the unique considerations specific to this patient group. We suggest that future recommendations incorporate additional specifications about the appropriateness of each instrument for all levels of TBI severity, and providing additional recommendations that are more appropriate for studies involving TBI patients with mild TBI.

Summary and Conclusion

The above recommendations provide guidance on the use of outcome instruments by researchers conducting psychosocial research in individuals with a moderate-to-severe TBI. These recommendations represent a significant advance in the forging of a strong research environment by building research capacity in psychosocial function after TBI. By using a common set of instruments that have been judged by a panel of experts to be most appropriate for psychosocial research, researchers can enhance their research efforts and findings. The use of a common set of recommended outcomes, in particular, will better allow research outcomes to be compared, and

allow data to be pooled so that significantly larger samples can be collectively examined. Future amendments to these recommendations will allow for the accommodation of new emerging instrument and new emerging areas of psychosocial research.

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The following authors report a financial conflict of interest as an author or co-author of assessment instruments recommended by the Workgroup from which royalty income is/will be generated.

Skye McDonald – The Awareness of Social Inference Test

Additional instruments recommended that are authored by the Moving Ahead Working Group although are available in the public domain include the following. Note these authors did not contribute to the discussion of the instrument's inclusion in the recommendations.

Robyn Tate – Sydney Psychosocial Rehabilitation Scale and the Care and Needs Scale.

Jennifer Fleming – Self-Awareness of Deficits Interview

Jennie Ponsford – Brain Injury Questionnaire on Sexuality

Jacinta Douglas – La Trobe Communication Questionnaire

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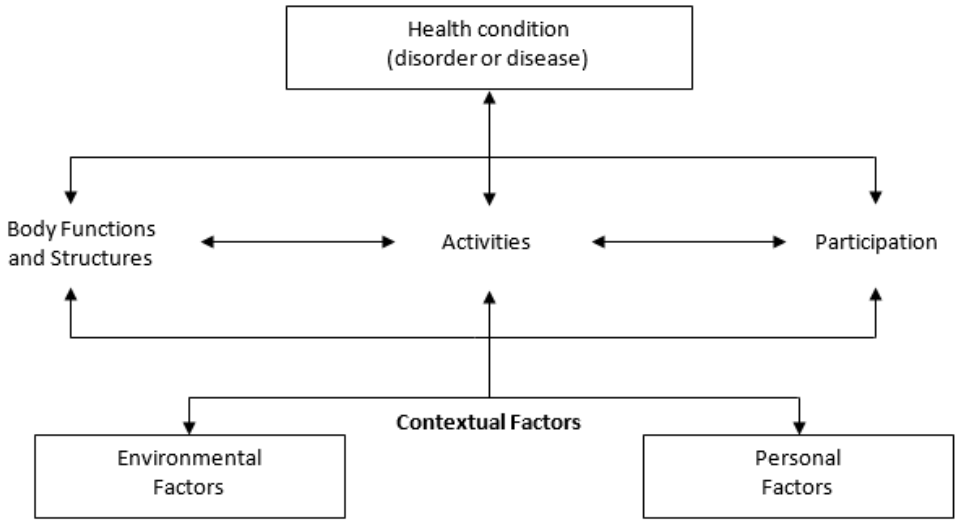

Figure 1. The ICF Model depicting interaction between the components Functioning and Disability and Contextual Factors. Adapted from "*International classification of functioning, disability and health*" by World Health Organisation. Geneva: World Health Organisation. Copyright 2001 by the World Health Organisation.

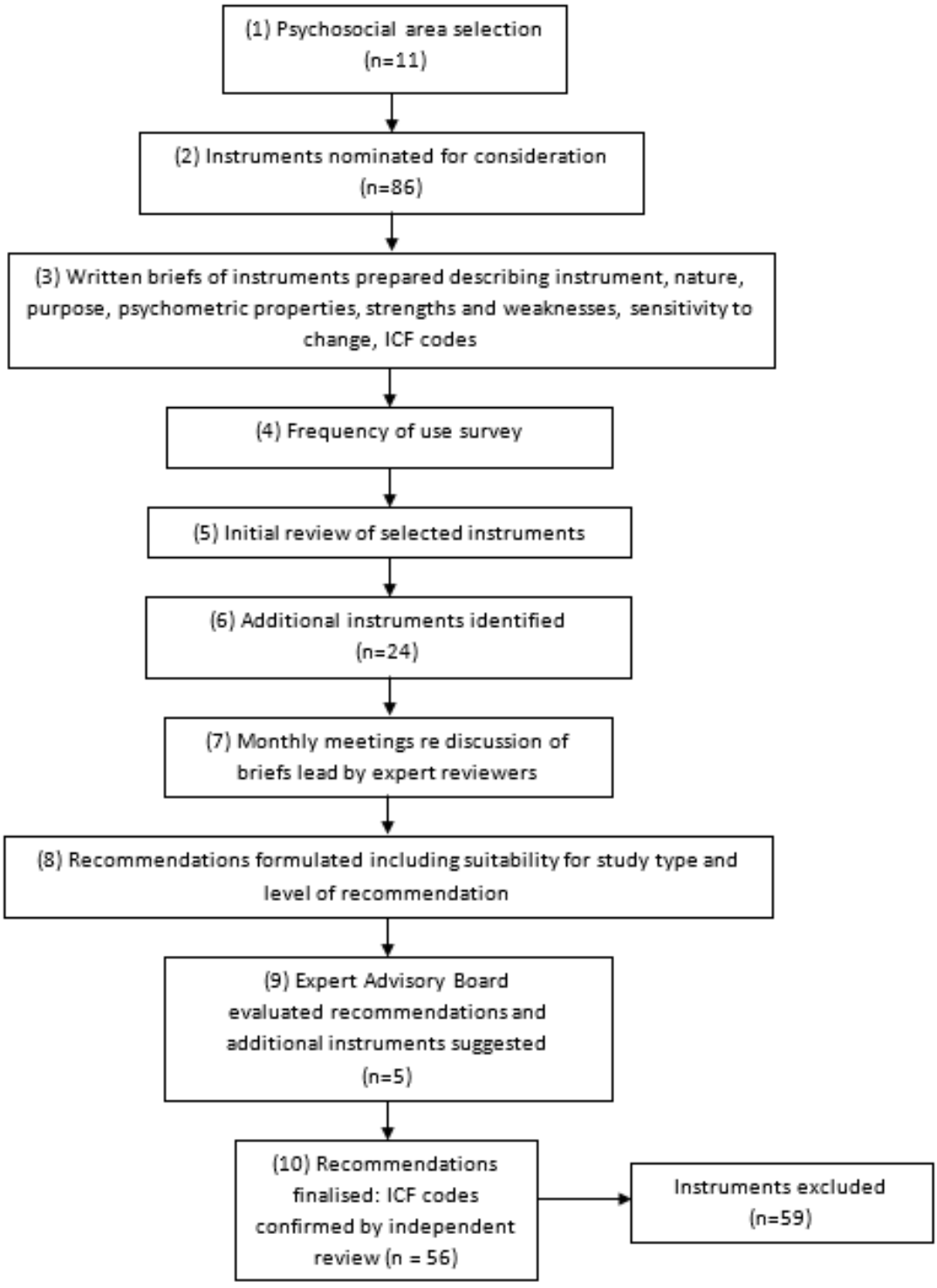

Figure 2. Overview of steps involved in instrument selection for outcome measure recommendations for use in psychosocial research

Table 1.

Psychosocial outcome domains and descriptions

ICF Domain & Psychosocial Area	**Description**
Global Outcome	Global outcome includes an assessment of the overall impact of TBI. This incorporates functional status and recovery, level of adjustment, independence or level of support required, and participation.
ICF – Body Functions (b)	
Communication	Communication difficulties are common following TBI and may lead to relationship, social functioning and vocational difficulties. Such communication difficulties may include language comprehension, pragmatic understanding, speech production and articulation, literacy and level of social interaction.
Social Cognition	Meaningful social interactions rely on intact social cognition, which encapsulates abilities related to recognising the emotional state of others, empathy, seeing things from the perspective of others, and gauging the intentions behind the actions of others. Impaired social cognition is a common, and often chronic, outcome of TBI.
Behavioural and Executive Function	Behavioural dysfunction following traumatic brain injury is frequently reported and may result in various negative outcomes including relationship, social functioning, and vocational difficulties. Examples include disinhibited, impulsive or aggressive behaviours, and apathy or loss of motivation.

Other Neuropsychological Functioning	Impairments in cognitive functioning are common outcomes of TBI which affect everyday functioning and participation. Such impairments may include slowed processing speed and difficulties with attention, memory and executive function.
Psychological Status	There are various psychological issues associated with TBI which may affect the level of adjustment and may impact on long-term outcomes. These issues may include mood disturbances, substance use, and subjective distress following traumatic events.
TBI-Related Symptoms	Apart from the psychological, cognitive and behavioural symptoms of TBI, there are other TBI-related symptoms that may affect psychosocial outcomes. These include sleep quality and the level of sleepiness and fatigue.
ICF -Activities/Participation (d)	
Activities and Participation*	Participation is defined by the World Health Organization (WHO) as "involvement in life situations", and commonly includes engagement in endeavours within one's community. TBI affects many areas of participation including work/ productive activity, recreation and leisure pursuits, and social/ family role function.
ICF - Environmental Factors (e)	
Support and Relationships	Family and other environmental factors may be important moderators of functional outcomes in people with TBI. Such moderating factors may include caregiver burden, family functioning, the extent and structure of social networks, and social support.

ICF – Personal Factors	
Sense of Self#	There are various components of the self that moderate outcomes following TBI. These include an awareness of functional abilities or limitations, level of motivation to seek help, level of self-esteem, and self-concept (past, present, and future).
Concepts not covered in ICF	
Health-Related Quality of Life	Reduced health-related quality of life is a common consequence of TBI. Health-related quality of life is an individual's perception of their life in relation to physical and occupational functioning, psychological functioning, and social functioning.

Note. The above descriptions are modified versions of the descriptions provided by McCauley et al. (2012) and Wilde et al. (2010). * This definition is consistent with the Social Role Participation and Social Competence description provided by McCauley et al. and Wilde et al. # Sense of Self is a new domain that was created by the Moving Ahead CRE Outcome Measures Workgroup.

Table 2.

Psychosocial Outcome Measure Instrument Selection Guidelines

Guidelines
1. Sufficient representation in scientific literature and/or widespread use in psychosocial research of moderate-to-severe TBI.
2. Evidence of sound psychometric properties relevant to a moderate-to-severe TBI population.
3. Well-established normative/comparison data and international normative/comparison data.
4. Applicability across a range of severity, functional levels, and developmental levels.
5. Availability in the public domain.
6. Ease of administration (i.e. minimal complexity in administration and scoring).
7. Brevity.
8. Continuity with US-based TBI Common Data Elements instruments where possible.

Table 3

Recommended instruments by ICF domain and psychosocial area

Instrument	ICF	Study Type			Δ
		R	I	O	
Global Outcomes					
Glasgow Outcome Scale-Extended (GOS-E)	b110, d5, d6, d7, d8, d9	C	C	C	N
Health of the Nation Outcome Scales – Acquired Brain Injury Version (HoNOS-ABI)	b1, d5, d6, d7, e3	S	S	S	N
Mayo-Portland Adaptability Inventory (MPAI-4)	b1, b2, d3, d4, d5, d7, d8, d9	S	S	S	✓
ICF – Body Functions (b)					
Communication					
Western Aphasia Battery-Revised; Aphasia Quotient (TBI Bank Protocol)	b167	S	S	S	✓
Frenchay Dysarthria Assessment-2 Edition	b167	S	S	S	✓
Boston Naming Test (BNT)	b167	S	S	S	✓
Functional Assessment of Verbal Reasoning and Executive Strategies (FAVRES)	b164, b167	N	S	S	N
Adapted Kagan Scales for TBI Interactions; Support in Conversation and Participation in Conversation	d3, b167	S	S	S	✓
Profile of Pragmatic Impairment in Communication (PPIC)	d3, b167	S	S	S	✓
Discourse Tasks (TBI Bank Protocol)	d3, b167	S	S	S	N
LaTrobe Communication Questionnaire (LCQ)	d3, b167	S	S	S	✓
Social Cognition					
The Awareness of Social Inference Test (TASIT) and The Awareness of Social Inference Test-Short (TASIT-S)	b122, d7	S	S	S	✓
Interpersonal Reactivity Index (IRI)	b122, d7	S	S	S	N

Behavioural and Executive Function					
Overt Behaviour Scale (OBS)	b130, b164	S	S	S	✓
Dysexecutive Questionnaire (DEX)	b130	S	S	S	N
Behaviour Rating Inventory of Executive Function-Adult (BRIEF-A)	b130, b164	S	S	S	N
Other Neuropsychological Functioning					
Shipley-2	b117, b164	S	S	S	
Wechsler Adult Intelligence Scale-IV (WAIS-IV); Digit Span	b140	S	S	S	
WAIS-IV; Processing Speed Index (PSI)	b147	S	S	S	
Wechsler Memory Scale-IV (WMS-IV); Logical Memory I & II (LM I & LM II)	b144	S	S	S	
Rey Auditory Verbal Learning Test (RAVLT)	b144	S	S	S	
Trail-Making Test (TMT)	b140, b164	S	S	S	
Controlled Oral Word Association Test (COWAT) & Animal Naming	b164	S	S	S	
Psychological Status					
Alcohol Use Disorders Identification Test (AUDIT)	b1303, e110	S	S	S	
Drug Abuse Screening Test (DAST)	b1303, e110	S	S	S	
Hospital Anxiety and Depression Scale (HADS)	b152	S	S	S	✓
Beck Hopelessness Scale (BHS)	b152	S	S	S	✓
Beck Scale of Suicidality (BSS)	b152	S	S	S	N
Brain Injury Questionnaire of Sexuality (BIQS)	b640, d7702	S	S	S	N
Impact of Life Events Scale-Revised (ILES-R)	b152, d240	S	S	S	✓
TBI-Related Symptoms					
Epworth Sleepiness Scale (ESS)	b134	S	S	S	✓
Pittsburg Sleep Quality Index (PSQI)	b134	S	S	S	✓
Fatigue Severity Scale (FSS)	b130	S	S	S	✓
Modified Fatigue Impact Scale (mFIS)	b130	S	S	S	N

ICF -Activities/Participation (d)					
Activities and Participation					
Craig Handicap Assessment and Reporting Technique (CHART)	d1, d2, d3, d5, d6, d7, d8, d9	-	S	S	N
Sydney Psychosocial Reintegration Scale (SPRS)	d2, d3, d4, d5, d6, d7, d8, d9	S	S	S	✓
Dyadic Adjustment Scale (DAS)	d710, d720, d770	S	S	S	✓
World Health Organisation Disability Assessment Schedule 2.0 (WHODAS 2.0)	d1, d3, d4, d5, d6, d7, d8, d9	E	E	E	N
Nottingham Leisure Questionnaire (NLQ)	d9	S	S	S	✓
Canadian Occupational Performance Measure (COPM)	d4, d5, d6, d7, d8, d9	S	S	S	✓
ICF - Environmental Factors (e)					
Support and Relationships					
The Caregiver Strain Index (CSI)	N/A*	S	S	S	N
Family Assessment Device (FAD)	N/A*	S	S	S	N
Lubben Social Network Scale (LSNS)	e3	S	S	S	N
Social Support Survey (SSS)	e3	S	S	S	N
Care and Needs Scale (CANS)	e3	S	S	S	✓
ICF – Personal Factors					
Sense of Self					
Self Awareness of Deficits Interview (SADI)	b1644	S	S	S	✓
Patient Competency Rating Scale-Neurorehabilitation (PCRS-NR)	b1644	S[#]	S	S	✓
Head Injury Semantic Differential Scale - III (HISDS-III)	b1801, b126, b130	S	S	S	✓
Tennessee Self-Concept Scale, Second Edition (TSCS-2)	b1801, b126, b130	-	S	-	✓
Rosenberg Self-Esteem Scale (RSES)	b1266	S	S	S	N

The Motivation for Traumatic Brain Injury Rehabilitation Questionnaire (MOT-Q)	PF	-	S	-	N
BIRT Motivation Questionnaire (BMQ)	PF	E	E	E	N
Concepts not covered in ICF					
Health-Related Quality of Life					
EuroQol-5D (EQ-5D)	N/A*	S	S	S	✓
Satisfaction with Life Scale (SWLS)	N/A*	S	S	S	✓
World Health Organisation Quality of Life BREF (WHOQOL-BREF)	N/A*	S	S	S	✓
Traumatic Brain Injury Quality of Life (TBI-QoL)	N/A*	S	S	S	✓

Note. * Concept not covered in ICF, # The brief 13 item version is appropriate for early recovery, R = Early recovery, I = Intervention Studies, O = Outcome Studies, C = Core, B = Basic, S = Supplemental, E = Emerging, Δ = sensitive to change. N = not enough evidence; N/A = not available. PF = Personal Factors, code not available.

Brief Description of Recommended Outcome Instruments for Use in Psychosocial Research

Supplemental Paper to

"Outcome Instruments in Moderate-to-Severe Traumatic Brain Injury:

Recommendations for use in Psychosocial Research"

The recommended instruments are summarised in Tables s1a to s1k (presented at the end of this document) grouped by psychosocial area and ICF domain. In total, 56 instruments were recommended (a full listing of other instruments considered is shown in Table s2). Brief descriptions of the content of each recommended instrument are provided below. The information is organised according to the taxonomy of the World Health Organisation's International Classification of Functioning (ICF; World Health Organisation (WHO), 2001) and areas of psychosocial functioning.

Multiple ICF Components

Global Outcomes

Three versions of the Glasgow Outcome Scale (GOS) currently exist: the original 5-category GOS (Jennett & Bond, 1975), an expanded 8-category version (8-GOS; Jennett, Snoek, Bond, & Brooks, 1981), and an extended interview-format version (GOS-E; Teasdale, Pettigrew, Wilson, Murray, & Jennett, 1998). All versions address the same areas: physical and mental functioning and their effects upon social functioning. The GOS-E is recommended as the Core measure. This uses a structured interview and hierarchical decision-tree to evaluate functioning in specific domains: consciousness, independence at home and outside, work, social and leisure activities, family and friends, and return to normal life. It classifies outcome into a single, discrete category: Death, Persistent Vegetative State, Severe Disability, Moderate Disability or Good Recovery. The GOS-E further subdivides the last three categories in terms of higher or lower levels of functioning. Administration time GOS-E is 10 minutes.

The Mayo-Portland Adaptability Inventory – 4 (MPAI-4; Malec & Lezak, 2008) contains 29 core items representing the common sequelae of ABI. Three subscales comprise Ability (sensory, motor, cognitive function), Adjustment (mood, interpersonal interactions) and Participation (social contacts,

initiation, money management). A fourth subscale, for pre-existing and associated conditions, is not scored. Clinician, informant and self-report versions are available, responses being made on a 5-point scale: 0 (mild problem that does not interfere with activities) to 4 (interferes with activities more than 75% of the time). The manual provides instructions for scoring and interpretation, along with comparison data. Administration time is approximately 10 minutes.

The 12-item Health of the Nation Outcome Scales-Acquired Brain Injury (HoNOS-ABI; Coetzer & Du Toit, 2001) contains the same items as the original HoNOS (Wing, Beevor, & Curtis, 1998), but the glossary is more targeted to the typical manifestation characteristics of ABI as opposed to psychiatric disorders (Tate, 2010). Items cover four domains: behavioural, impairment (cognition, physical health), symptoms (hallucinations, delusions, depression, other symptoms), and social (social relations, general functioning, housing, activities). Administration time is 5-8 minutes using clinician ratings made on a scale of 0 (no problem) to 4 (equivalent of severe/very severe problem).

Body Functions (b): Mental Functions (b1)

Communication

The Western Aphasia Battery-Revised (WAB-R; Kertesz, 2007) evaluates the presence, severity and type of aphasia. It comprises eight subtests (32 short tasks), the first four of which contribute to the Aphasia Quotient: Spontaneous Speech (Part 1: conversational questions and picture description), Auditory Verbal Comprehension (Part 1: yes/no questions, auditory word recognition, sequential commands), Repetition (Part 1: for words, phases, and sentences), Naming and Word Finding (Part 1: objective naming, word fluency, sentence completion, responsive speech). Administration time is approximately 45 minutes.

The 15-item Frenchay Dysarthria Assessment-2 Edition (FDA-2; Enderby & Palmer, 2008) is a standardised measure for the differential description and diagnosis of dysarthria. Items assess 11 aspects of motor speech and communication ability: Reflex, Respiration, Lips, Palate, Laryngeal, Tongue, Intelligibility, Rate, Sensation and Associated factors. The FDA-2 rating scale can be

converted to a quantifiable scale with 'e' (unable to undertake task/movement/sound) corresponding to zero and 'a' (normal task/movement/sound' for age) corresponding to four. The FDA-2 score results from the seven quantifiable sections with a possible total score of 104 indicating the best oromotor performance. Normative data are available in the manual. Administration time is approximately 20 minutes.

The 15-item Boston Naming Test Second Edition Short Form (BNT-S; Kaplan, Goodglass, Weintraub, & Segal, 1983), which assesses noun naming ability, takes every fourth item from the original 60-item BNT (Mack, Freed, Williams, & Henderson, 1992). Administration time is approximately 15 minutes. A total score is derived for which normative data are available.

The Functional Assessment of Verbal Reasoning and Executive Strategies (FAVRES; MacDonald & Johnson, 2005) assesses verbal reasoning, complex comprehension, discourse, and executive functioning using four tasks that simulate real world communication demands: planning an event, scheduling a work day, deciding on a gift, and building a case to solve a problem. The FAVRES requires processing of 'real life' amounts of information, analysis of several factors, integration of various stimuli, and formulation of written and oral responses. Performance is scored for completion time, accuracy of solution (from 0-5 points) and reasons (0-5 points) summed across the tasks. The original study reports norms for 101 relatively well-educated adults. Administration time is 60 minutes (15 min per task), but varies according to individuals.

The Adapted Kagan Scales for TBI Interactions (Kagan et al., 2004) contain two subscales. The Measure of Participation in Conversation (MPC) subscale examines the ability of the person with TBI to participate in interactional and transactional elements of conversation (Togher, Power, Tate, McDonald, & Rietdijk, 2010). The Measure of Support in Conversation (MSC) subscale rates the uninjured communication partner's ability to acknowledge and reveal communication competence of the person with TBI. Administration involves rating a 10-minute video recording of a social interaction between the person with TBI and their communication partner. The recording is rated on 9-point Likert-type scales from 0 (no participation) to 4 (full participation) with half point

increments: The MPC subscales for Interaction and Transaction (verbal and non-verbal); the MSC subscales for Acknowledging and Revealing Competence. Normative data are not yet available.

The Profile of Pragmatic Impairment in Communication (PPIC; Hays, Niven, Godfrey, & Linscott, 2004) measures social communication skills. It is based on principles of social communication and the specific impairments associated with TBI. The PPIC contains 84 clinician-rated items and 10 summary scales: Logical Content, General Participation, Quantity, Quality, Internal Relation, External Relation, Clarity of Expression, Social Style, Subject Matter, and Aesthetics. Ratings are made on a 6-point scale from normal (0) to very severely impaired (5) after viewing the individual interact socially over a period of 15 minutes. Time required to rate the individual is approximately 10 minutes (Linscott, Knight, Godfrey, 1996). Little normative data are currently available.

Discourse Tasks (Coelho, Ylvisaker, & Turkstra, 2005) form part of the TBI Bank Protocol http://www.talkbank.org/tbibank/ and comprises four tasks: free speech samples, picture description (relating a story about three pictures), familiar story narrative, and procedural discourse (i.e., providing instructions to make a sandwich). Administration time is 55 minutes. While a number of approaches to analysing the discourse are available in the literature (Coelho et al., 2005; Turkstra, Quinn-Padron, Johnson, Workinger, & Antoniotti, 2012), there are no generally agreed approaches for assessing discourse. Normative data are unavailable.

The 30-item Latrobe Communication Questionnaire (LCQ; Douglas, O'Flaherty, & Snow, 2000) is a rating scale measuring perceived communicative ability. It contains six empirically derived components: Conversational Tone, Effectiveness, Flow, Engagement, Partner Sensitivity, and Conversational Attention/Focus. Informant/close other and self-report versions are available. Responses are made on a 4-point scale: 1 (never or rarely) to 4 (usually or always), deriving a total score (range 30-120). Discrepancy ratings between self and close other report can be used to index awareness of communication problems. A second response format, change, with three categories (more, same, less) is available to elicit preinjury versus post-injury and pre-intervention versus post-

intervention judgments of change or judgments of change over specified periods of time. Administration time with informants is approximately 15 minutes, and 30 minutes using interview-format with people with TBI. Normative data for 147 young adults and close others, and clinical data for 88 adults with severe TBI and 71 close others are available (Douglas, Bracy, & Snow, 2007).

Social Cognition

The Awareness of Social Inference Test (TASIT; McDonald, Flanagan, Rollins, & Kinch, 2003) measures the ability to understand emotions, beliefs and intentions (i.e., theory of mind) of speakers by integrating cues from facial expressions, prosody, gesture, and social context of target characters in videotaped conversational interactions. Part 1: The Emotion Evaluation Test comprises 28 short video clips portraying one of the six basic emotions; Part 2: Social Inference – Minimal comprises 15 video clips depicting sincere and sarcastic interactions between two actors; Part 3: Social Inference - Enriched comprises 16 vignettes examining the ability to detect deception in social encounters and sarcasm. TASIT has two alternative forms and administration time is approximately 60 minutes. Normative data are available for 283 adults (McDonald et al., 2003) and 464 adolescents (McDonald et al., 2015). A short version (TASIT-S; Honan, McDonald, Sufani, Hine, & Kumfor, 2016) with fewer items (10 items in Part 1, and 9 items in each of Parts 2 and 3) was developed using Rasch and confirmatory factor analysis. The TASIT-S takes approximately 30 minutes to administer and preliminary normative data are available (n = 43).

The 28-item Interpersonal Reactivity Index (IRI; Davis, 1980; 1983) is a rating scale assessing dispositional empathy. It contains four 7-item subscales: Perspective Taking (cognitive empathy), Empathic Concern (emotional empathy), Personal Distress, and Tendency to Fantasise. Normative data are limited to 53 males and 56 females (Davis, 1980) and small experimental studies (e.g., de Sousa et al., 2010). Administration time is approximately 10-15 minutes.

Behavioural and Executive Function

The 9-category Overt Behaviour Scale (OBS; Kelly, Todd, Simpson, Kremer, & Martin, 2006) can be used as an observational instrument or clinician rating scale to evaluate challenging behaviours.

Items address verbal aggression, physical aggression against objects, self, and other people, inappropriate sexual behaviour, perseveration/repetitive behaviour, wandering/absconding, inappropriate social behaviour, and lack of initiative. Each behaviour is dichotomously scored as present or absent and, for those items endorsed, a subscale is completed regarding severity, frequency and impact of the behaviour. A number of different scores are derived: cluster score for the number of categories in which the challenging behaviour occurs (range 0-9), levels score for the number of subcategories endorsed (range 0–34), and a severity score (ranges 0 to 84). Administration time is reported as 5-10 minutes. Comparison data for 507 people with TBI are available in Sabaz, Simpson, Walker, Rogers, Gillis and Strettles (2014).

The 20-item Dysexecutive Questionnaire (DEX*;* Burgess et al., 1996), which is a subtest of the Behavioural Assessment of the Dysexecutive Syndrome (Wilson, Alderman, Burgess, Emslie, & Evans, 1996), evaluates impairments associated with frontal systems dysfunction. Items encompass four domains: Emotional, Motivational, Behavioural and Cognitive. Items for both the clinician/informant and self-versions are rated on a 5-point scale: 0 (never) to 4 (very often). The total score ranges from 0 to 80, with higher scores indicating greater problems with executive functioning. In addition to assessing executive function, the discrepancy between self and informant responses can be used as a measure of self-awareness. A refined scoring procedure is also available (Simblett & Bateman, 2011). Administration time is 20 to 30 minutes.

The 75-item Behaviour Rating Inventory of Executive Function – Adult (BRIEF-A; Roth, Isquith, & Gioia, 2005) examines executive functioning and self-regulatory behaviour, sampling nine domains: Inhibition, Self-Monitoring, Planning and Organization, Shifting, Initiation, Task Monitoring, Emotional Control, Working Memory, and Organisation of Materials. Items are rated on a 3-point scale from 0 (never) to 2 (often). Three indices are derived: Behavioural Regulation, Metacognition, and an overall Global Executive Composite. The BRIEF-A also produces three validity scales (Negativity, Inconsistency and Infrequency). Using comparison of self-report and informant versions enables examination of

self-awareness. Administration time is 10-15 minutes. Normative data are well established and available for 18 to 90 years of age.

Other Neuropsychological Functioning

The Shipley-2 (Shipley, Gruber, Martin, & Klein, 2009) is the second version of the Shipley Institute of Living Scale. It measures two aspects of cognition: Crystallised Knowledge, as an estimate of premorbid cognitive functioning, is measured using a 40-item Vocabulary scale in multiple choice format; Fluid Reasoning is measured using either the Abstraction scale and/or the Block Patterns scale. Administration time is 20 to 25 minutes, shorter if only one of the Fluid Reasoning scales is used. The manual is used to calculate an Impairment Index, the difference between the Vocabulary scale and either of the Fluid Reasoning scales. A Shipley-2 Impairment Index Calculator is also available. Normative information is provided in the instrument's manual.

Digit Span and Processing Speed Index (PSI), from the Wechsler Adult Intelligence Scale–IV (WAIS-IV; Wechsler, 2008) examine working memory and processing speed respectively. Digit Span requires the repetition of increasing lengths of digit sequences (forwards and backwards). The PSI comprises two subtests requiring the rapid transcription of symbols to match digits (Coding) and search for symbols or shapes in a large array (Symbol Search or Cancellation). Administration time for Digit Span, and the PSI, is approximately 10 minutes each. Raw scores for individual subtests are converted to standard scores (M=10, SD=3) and the two PSI subtests are summed to yield an index (M=100, SD=15). The WAIS-IV has extensive norms for 16 to 90 years (n = 2,200).

Logical Memory (from the Wechsler Memory Scale-IV; Wechsler, Holdnack, & Drozdick 2009) is a subtest of the Auditory Memory Index. The examiner reads a short prose passage after which the respondent recounts as many details as possible both immediately and following a 25 to 35-minute interval. A recognition test follows the delay. Administration time is approximately 5 minutes. Scores are converted to standard scores (M=10, SD=3). Norms are available for 1,400 adults.

The Rey Auditory Verbal Learning Test (RAVLT; Rey, 1964; Schmidt, 1996) evaluates multiple aspects of verbal learning, including immediate memory span, new learning, susceptibility to interference, delayed memory and recognition memory. There are many variants of the RAVLT. The most common consists of 15 nouns (List A) read aloud for five trials, an interference list of 15 different nouns (List B), and a recognition list of 50 words. The RAVLT has extensive norms (Strauss, 2006). Administration time is approximately 15 minutes for the learning trial, and less than 5 minutes for delayed recall following a 20-minute delay.

The Trail Making Test (TMT; described in Lezak et al., 2012) provides information on visual search speed, scanning, speed of processing, and mental flexibility. The TMT comprises two parts: Part A contains 25 numbered circles (1-25) distributed in non-ordered manner on an A4 page which are to be connected by a line in ascending order. In Part B, the circles include both numbers (1–13) and letters (A–L) and a line is drawn from number to letter in an alternating manner (i.e., 1-A-2-B-3-C, etc.). Normative data are provided in Tombaugh (2004). Administration time is approximately 10 minutes.

The Controlled Oral Word Association Test (COWAT; Benton & Hamsher, 1976; Spreen & Strauss, 1988) and Animal Naming evaluates the spontaneous production of words under restricted search conditions and is sensitive to self-initiation, strategy formation, flexibility and response monitoring. In letter fluency (COWAT), as many words as possible beginning with a specific letter (F, A, S or C, F, L in the alternative version) are produced in 1 minute. In semantic fluency (Animal Naming), as many items as possible from a particular category are produced. Administration time for both tasks is approximately 5 minutes. Admissible responses are summed compared to normative data, multiple data sets being available (Ruff, Light, Parker, & Levin, 1996; Strauss, 2006; Tombaugh, Kozak, & Rees, 1999).

Psychological Status

The 10-item Alcohol Use Disorders Identification Test (AUDIT; Saunders, Aasland, Babor, Fuente, & Grant, 1993) screens for excessive drinking. It also provides a framework for intervention

to help hazardous drinkers reduce or cease alcohol consumption. Each item is accompanied by a set of responses, each scored from 0 to 4. A total score of 8 or higher indicates hazardous alcohol use, as well as possible alcohol dependence (scores above 0 on items 4–6). Administration time is less than 5 minutes.

The Drug Abuse Screening Test (DAST; Gavin, Ross, & Skinner, 1989) assesses psychoactive drug use, focusing on problems related to drug use and misuse (type and frequency of drug use is not evaluated). There are three versions: 28-item, 20-item and 10-item. Administration time varies between 5 to 15 minutes. On the 28-item version, a score of 6 or higher indicates a potential drug problem and 16 or higher very severe abuse or a dependency condition. The cut-off score for the DAST-10 is 3. DAST scores are highly diagnostic with respect to the Diagnostic and Statistical Manual of Mental Disorders diagnosis of psychoactive drug dependence.

The 14-item Hospital Anxiety and Depression Scale (HADS; Zigmond & Snaith, 1983) evaluates depression (7 items) and anxiety (7 items). Each item is rated on a 4-point scale from 0 to 3, with 3 indicating higher symptom frequency. Total scores for each subscale range from 0 to 21, categorised as normal (0–7), mild (8–10), moderate (11–14) or severe (15–21). Administration time is 5 minutes.

The 20-item Beck Hopelessness Scale (BHS; Beck, Weisman, Lester & Trexler, 1974) measures pessimism and negative attitudes about the future. Items are endorsed as true or false, resulting in a total score ranging from 0 to 20 with higher scores indicating greater negative expectations. Scores identifying severity levels (nil, mild, moderate, severe) are available, with a score of 9 or higher indicating clinically significant (at least moderate) levels of hopelessness. Administration time is 5-10 minutes. Comparison data for a TBI sample (*n*=172), including the factors, are available in Simpson and Tate (2002).

The Beck Scale for Suicide Ideation (BSS; Beck, Kovacs & Weissman, 1979) evaluates the intensity of suicidal intent reflected in self-destructive thoughts or wishes. Responses to 19 items are made on a 3-point scale from 0 to 2, with descriptors varying according to the item. The total score

is usually used (range: 0 to 38, with higher scores indicating higher levels of suicide ideation) rather than factor scores. Administration time is 5-10 minutes. Comparison data for a TBI sample (n=172), including the factors, are available in Simpson and Tate (2002).

The Brain Injury Questionnaire on Sexuality (BIQS; Ponsford, 2003) documents changes relative to pre-injury across a range of aspects of sexuality. It contains three subscales using 15 items: Sexual Functioning, Relationship Quality and Self-Esteem, and Mood (Stolwyk, Downing, Taffe, Kreutzer, Zasler & Ponsford, 2013). Items are rated on a 5-point scale from 1 (greatly decreased compared to preinjury) to 5 (greatly increased). The total score ranges from 15 to 75. Administration time is 5-10 minutes. Group comparison between a TBI (n=865) and matched control group (n=142) are available in Downing, Stolwyk and Ponsford (2013).

The 22-item Impact of Event Scale - Revised (IES-R; Weiss & Marmar, 1996) measures subjective distress caused by traumatic events. Respondents identify a specific stressful life event and rate degree of distress during the preceding 7 days on a 5-point scale from 0 (not at all) to 4 (extremely). Completion time is 5 minutes. Item scores are summed to give the total score (range 0-88). Scores can be also derived for Intrusion, Avoidance, and Hyperarousal subscales. Items of the IES-R correspond to 14 of the 17 post-traumatic stress disorder (PTSD) symptoms listed in the DSM-IV, although the IES-R is usually not used to diagnose PTSD.

TBI-Related Symptoms

The 8-item Epworth Sleepiness Scale (ESS; Johns, 1991) measures daytime sleepiness. Respondents rate the probability of falling asleep during everyday activities on a scale of 0 to 3. Scores between 11 and 15 indicate mild to moderate sleep apnea, and scores of 16 and above indicates severe sleep apnea or narcolepsy. Administration time is brief.

The 7-item Pittsburgh Sleep Quality Index (PSQI; Fictenberg, Putnam, Mann, Zafonte, & Millard, 2001) measures self-reported quality and patterns of sleep in seven areas: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. Administration time is brief. Each item is rated from 0 (Not

during the past month/Very good) to 3 (Three or more times a week/Very bad). A total score higher than 5 indicates poor sleep quality.

The 9-item Fatigue Severity Scale (FSS; Krupp, LaRocca, Muir-Nash, & Steinberg, 1989) measures the severity of fatigue and the degree to which it affects activities and lifestyle. Administration time is less than 5 minutes. Items are rated on a 7-point scale from 1 (strongly disagree) to 7 (strongly agree). Cut-off score of 4 or higher indicate problematic fatigue.

The 21-item Modified Fatigue Impact Scale (MFIS; Tellez et al., 2005) is a multidimensional instrument measuring the impact of fatigue in three domains: Physical, Cognitive, and Psychosocial. Items are rated on a 5-point scale, from 0 (never) to 4 (almost always). The MFIS yields a total score (0-84) and subscales for physical (0-36), cognitive (0-40) and psychosocial functioning (0-8). A 5-item version is also available. Administration time is approximately 5-10 minutes (5-item version is 2 minutes). The mFIS is to be used specifically if a measure of cognitive fatigue is required.

Activities/Participation (d)

Activities and Participation

The revised 32-item Craig Handicap Assessment and Reporting Technique (CHART; Mellick, Walker, Brooks, & Whiteneck, 1999) assesses handicap (participation restriction) in the community setting. It samples six dimensions: Physical Independence, Cognitive Independence, Mobility, Occupation, Social Integration, and Economic Self-sufficiency. Items sample objective, quantifiable information (e.g., number of hours, occasions, and contacts) and responses are recorded for later coding. The CHART is administered interview-style, taking approximately 15 minutes. For each dimension, raw scores are transformed to weighted scores, with score range 0 to 100, with higher scores indicating better social and community participation.

The Sydney Psychosocial Reintegration Scale-2 (SPRS-2; Tate, 2011) has a revised scoring format but retains the 12 items of the original scale (Tate, Hodgkinson, Veerabangsa, & Maggiotto, 1999). Items are grouped into three domains: Occupational Activity, Interpersonal Relationships, and Independent Living Skills. Additional unscored factual information is obtained in a 15-item

structured interview. The SPRS contains two forms with the same item content but with the response format phrased “change since injury” (Form A) or “current competency” (Form B) which capture both qualitative and quantitative function. Forms are available for clinician, self and informant ratings. Administration time with clinician face-to-face interview is approximately 15-20 minutes, but self/informant ratings take less than five minutes. Responses use a 5-point scale for both forms: 0 (extreme change/extremely poor) to 4 (no change/very good). The total score ranges from 0 to 48 (0-16 for each domain), with higher scores representing better levels of psychosocial reintegration. Comparison (Form A, *n*=510) and normative (Form B, *n*=107) data are available, along with a conversion table to obtain Rasch logit scores (Tate, Simpson, Soo, & Lane-Brown, 2011).

The 32-item Dyadic Adjustment Scale (DAS; Spanier, 1976) measures the quality of marriage and other cohabiting couple relationships. It contains four subscales which can be used independently: Consensus, Satisfaction, Cohesion, and Affectional Expression. Items are rated on a 6-point scale, with descriptors varying according to the item. The total score ranges from 0 to 160. Administration time is reported as a few minutes. Descriptive data for non-injured married (*n*=218) and divorced (*n*=94) are provided in Spanier (1976). Some comparison data in TBI and ABI samples are available (Kieffer-Kristensen & Teasdale, 2011; Peters, Stambrook, Moore, & Esses, 1990).

The World Health Organisation Disability Assessment Schedule 2.0 (WHODAS 2.0; WHO, 2004; available from www.who.int/icidh/whodas) is a generic multidimensional questionnaire that assesses health and disability in six domains: Cognition, Mobility, Self-care, Getting Along, Life Activities and Participation. Items are rated on a 5-point scale: 1 (no difficulty) to 5 (unable to perform the activity). Different versions and lengths of the tool are available and it can be administered via clinician interview, self- or informant. Administration time is 5-20 minutes.

The 30-item Nottingham Leisure Questionnaire (NLQ; Drummond & Walker, 1994) measures number and frequency of leisure activity. Items comprise a wide range of leisure activities, including solitary and social activities, physically active and passive, indoor and outdoor. Responses are made on a 3-point frequency scale: 0 (never) to 2 (regularly). Administration time is 10-15 minutes.

The Canadian Occupational Performance Measure (COPM*;* Law et al., 2014) is an individualised outcome measure used to guide client-centred occupational therapy and goal setting. A semi-structured interview is used to identify the person's needs, wants and expectations in three domains: self-care, productivity and leisure. Specific occupational areas are rated for their importance on a 10-point scale: 1 (not important at all) to 10 (extremely important). The COPM also measures status and change in self-perceived performance and satisfaction using similar 10-point rating scales prior to and following an intervention. Median administration time is 30 minutes, but varies greatly.

Environmental Factors (e)

Support and Relationships

The 13-item Caregiver Strain Index (CSI*;* Robinson, 1983) measures strain related to care provision. It contains at least one item for each of the following areas: Employment, Financial, Physical, Social, and Time. Items are endorsed if strain is present and are summed to a total score (range 0-13), with a cut-off score of 7 or higher signaling significant strain. Although it was developed for caregivers of recently hospitalised older adults, it has been used with (generally younger) people with TBI (Goodwin, Lincoln, & Bateman, 2016; Mazlan, Ghani, Tan, & Subramanian, 2015). Administration time is 5-10 minutes.

The 53-item Family Assessment Device (FAD; Miller, Bishop, Epstein, & Keitner, 1985) is based on the clinically-oriented McMaster Model of Family Functioning. It contains six scales reflecting dimensions of family functioning: Problem Solving, Communication, Roles, Affective Responsiveness, Affective Involvement, and Behavior Control, as well as a General Functioning scale. For each subscale scores range from 1 (healthy functioning) to 4 (unhealthy functioning). Administration time is 15-20 minutes.

The Lubben Social Network Scale-Revised (LSNS-R; Lubben & Gironda, 2004) measures structural social support. Although originally developed for older people, it has also been used for TBI (MacMillan, Hart, Martelli, & Zasler, 2002). The 12-item LSNS-R focuses on social networks of Family (6 items) and Friendships (6 items); Neighbours (6 items) are included in an 18-item version.

A 6-item version contains three items from both the Family and Friendships subscales. Administration time is 5-10 minutes. Responses are made on a 6-point scale, with response descriptors varying according to item content. The score range for the 18-item LSNS-R is 0-90, with higher scores indicating larger social networks and more frequent social contact.

The Social Support Survey (SSS; Sherbourne & Stewart, 1991) evaluates perceived availability of functional social supports. It was initially developed for people with "chronic conditions" and has been used with people with TBI (Fleming, Kuipers, Foster, Smith, & Doig, 2009; Lin et al., 2010). Nineteen items represent five dimensions of functional social support: Emotional Support, Informational Support, Tangible Support, Affectionate Support, and Positive Social Interactions. Two additional unscored items provide contextual background. Responses for the 19 functional items are made on a 5-point scale: 1 (none of the time) to 5 (all of the time); the total score ranges from 19-95. Administration time is approximately 10 minutes.

The Care and Needs Scale (CANS; Tate, 2004) assesses support needs for everyday activities and community living after TBI. It is a clinician rating scale, which is quick to complete, and can also be administered in interview format (taking 10-15 minutes). The CANS is completed in two steps: The 24-item Needs Checklist documents the type of support needed in four hierarchically-organised groups: high level needs, basic activities of daily living, instrumental activities of daily living and psychosocial functioning, and informational and emotional supports. Information from the Needs Checklist is used to identify one of seven Support Levels regarding the extent of support in terms of the frequency of required contact: 0 (completely independent) to 6 (cannot be left alone). Comparison data on 507 community-dwelling people with TBI are available in Sabaz et al. (2014).

Personal Factors

Sense of Self

The Self-Awareness of Deficits Interview (SADI; Fleming, Strong, & Ashton, 1996) is a semi-structured interview, assessing both quantitative and qualitative aspects of the person's awareness. The interview contains three parts: knowledge of any impairments or changes that have occurred

since the injury, awareness of the functional consequences of the impairments, and future plans, goals and expectations. Administration time is approximately 20 to 30 minutes. Each section is scored from 0 (accurate knowledge of deficits, consequences, and realistic appraisal) to 3 (no knowledge of deficits, consequences, or realistic appraisal), and combined to give a total score (range 0-9).

The 30-item Patient Competency Rating Scale (PCRS; Prigatano et al., 1986) is used to assess self-awareness using discrepancy ratings between participant and informant. Ratings are made on a 5-point scale: 1 (can't do) to 5 (can do with ease) in activities of daily living, behavioural and emotional function, cognitive abilities, and physical function. A 13-item short form was developed for use in inpatient neurorehabilitation (Borgaro & Prigatano, 2003). Administration time is 10-15 minutes.

The Head Injury Semantic Differential Scale - III (HISDS-III; Carroll & Coetzer, 2011) is a revision of the HISDS (Tyerman & Humphrey, 1984) which assesses self-concept. The HIDSIII comprises 18 adjective-pairs rated on a 7-point scale: 1 (negative pole) to 7 (positive pole). Ratings are summed to give a total score (range 18-126). Ratings can be obtained for past, present, future and ideal self. Factor analysis of the original HISD identified six factors: Self-esteem, Boredom, Sociability, Positive expectation, Negative Affect, and Caring/Unfeeling. The HISD III also uses a separate relative's version comprising 18 adjective-pairs (16 common items plus two items not rated by the person with TBI). Administration time is approximately 10 minutes.

The Tennessee Self-Concept Scale-2 (TSCS-2; Fitts & Warren, 1997) assesses self-concept in six scales: Physical, Moral, Personal, Family, Social, and Academic/Work, and also incorporates validity scores (Inconsistency, Faking Good, Self-criticism). It comprises 82 self-descriptive statements rated on a five-point scale ("always true" to always false"). Two summary scores are derived: Total Self-Concept and Conflict. Administration time is approximately 10-20 minutes. It is easily scored by hand in a few minutes or via a computer program that generates an interpretive report.

The 10-item Rosenberg Self-Esteem Scale (RSES; Rosenberg, 1965) measures state self-esteem and comprises a set of statements with responses made on a 4-point scale: 1 (strongly disagree) to 4 (strongly agree). Administration time is approximately 5 minutes.

The 31-item Motivation for Traumatic Brain Injury Rehabilitation Questionnaire (MOT-Q; Chervinsky et al., 1998) assesses motivation to participate in post-acute rehabilitation. There are four subscales: Lack of Denial, Interest in Rehabilitation, Lack of Anger, and Reliance on Professional Help. Responses to items use agreement ratings: -2 (strongly disagree) to +2 (strongly agree). Items are keyed on a scoresheet, with positive numbers representing greater motivation. Maximum score is 62. Administration time is 10-15 minutes.

The 34-item BIRT Motivation Questionnaire (BMQ; Oddy, Cattran, & Wood, 2008) measures a number of components of motivational change following brain injury including motivational deficits secondary to other sequelae (e.g., poor organisation), as well as those secondary to psychological reaction to brain injury (e.g., loss of confidence). Both self-report and relative versions are available. Statements are rated on a 4-point scale: 1 (always) to 4 (never). The total score ranges from 34 to 136, with higher scores representing greater difficulties in motivation.

Concepts Not Covered By ICF

Health-Related Quality of Life

The EuroQol-5 Dimensions (EQ-5D; EUROQOL Group, 1990) is a simple and generic quality of life scale. The most recent version, the EQ-5D-5L, includes the EQ visual analogue scale (VAS), which records the respondent's self-rated health on a 20cm vertical scale from 'the best health you can imagine" to 'worst imaginable health state', and a 5-item scale addressing five dimensions (Mobility, Self-Care, Usual Activities, Pain/Discomfort, Anxiety/Depression) rated on a 5-point scale of symptom severity from 'no problems' to 'extreme problems' (Herdman et al., 2011). Scores for each item may be used descriptively, or converted into a single index value using an EQ-5D-5L Crosswalk Index Value Calculator available for download on the EuroQol website. Administration time is approximately 8 minutes.

The Satisfaction with Life Scale (SWLS; Diener, Emmons, Larsen, & Griffin, 1985) provides a measure of "global life satisfaction". The five items examine life satisfaction as a whole on a 1-point scale from 1 (strongly disagree) to 7 (strongly agree). The total score ranges from 5 to 35, with score 20 representing the midpoint between satisfied and dissatisfaction with life (Pavot & Diener, 1993). Administration time is approximately 3 minutes.

The 26-item World Health Organisation Quality of Life BREF (WHOQOL-BREF; WHOQOL Group, 1998) is an abbreviated version of the WHOQOL-100 assessing quality of life. Two questions examine the global perspective. The remaining 24 items focus on four domains: Physical Health, Psychological, Social Relationships, and the Environment. All items are rated on a 5-point scale with varying descriptors and domain scores are scaled in a positive direction such that higher scores denote higher quality of life. Administration time is approximately 10 minutes.

The Traumatic Brain Injury Quality of Life (TBI-QoL; Tulsky et al., 2016) is a newly developed multidimensional questionnaire and assesses quality of life across four domains: Physical Health, Emotional Health, Cognition and Social Participation. Each domain contains additional "question banks". Items are rated on a 5 point-scale: 'Never', 'Not at all', 'None to always', 'Very Much' and 'Cannot Do'. Question banks are scored by summing the responses and converting the total to a T-score using conversion tables. The reference group comparisons are integrated from the Patient Reported Outcomes Measurement Information System (PROMIS) and the Neurological QoL (Neuro-QoL) measures, although there are question banks that have a TBI-specific reference group. The TBI-QOL can be administered in computerised and paper and pen forms.

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Table s1a.

Recommendations for Global Outcomes Instruments

TEST	ICF	Type of study			Δ	Psychometrics	Strengths	Weaknesses
		R	I	O				
Glasgow Outcome Scale-Extended (GOS-E)	b110, d5, d6, d7, d8, d9	C	C	C	N	*Reliability: Test-retest/inter-rater:* Same rater, different mode, 6 days apart (k = .92), different raters 16 days apart (k = .84) (Pettigrew, Wilson, & Teasdale, 2003) *Construct validity*: 5-10 months post injury: GOS-E and DRS: *r* = -.89, Barthel Index: *r* = .46 and duration of Post-traumatic Amnesia (*r* = .52). (Wilson, Pettigrew, & Teasdale et al., 2000).	Interview schedule has excellent inter-rater reliability and temporal stability. Administration is quick due to hierarchical approach.	Provides general index of global outcome, without detail of specific difficulties.
Health of the Nation Outcome Scales – Acquired	b1, d5, d6, d7, e3	S	S	S	N	*Reliability: Inter-rater:*(HoNOS): 12 items: ICC = .49- .97 (Wing et al., 1998); HoNOS-ABI: 10 items .58-.97 (Fleminger et al., 2005); *Test-*	Extensive rater training is not necessary: the authors of the test recommend one day of training	Psychometric data are limited for the HoNOS-ABI, though promising for the HoNOS.

Brain Injury Version (HoNOS-ABI)						*retest:HoNOS:*.63-.90 (1 week) (Orrell, Yard, Handysides, & Schapira, 1999); *Validity*: *Construct*: Not a single scale; 4-5 factors identified (Pirkis et al., 2005); *Convergent*: HoNOS with BPRS; *r* = .49-.71; with RFS .65 (Wing et al., 1998); HoNOS-ABI with PAI (*r* = .75) and with GMHP (*r* = .45) (Coetzer & Du Toit, 2001)	initially then a half day every two years to maximise inter-rater reliability. Quick to complete (<10 minutes; Tate, 2010)	Audin, Margison, Clark, and Barkham et al. (2001) suggested that the HoNOS does not provide adequate coverage of the range of problems presented by psychiatric patients, and that its usefulness in measuring change is limited.
Mayo-Portland Adaptability Inventory (MPAI-4)	b1, b2, d3, d4, d5, d7, d8, d9	S	S	S	✓	*Reliability: Internal consistency:* α = .89; *Inter-rater*: N/A *Test-retest N/A; Validity:* (MPAI-I only): C*onvergent:* Cognitive Index: RAVLT, *r* = -.55, WCST, *r* = .56; D*ivergent*: Non-cognitive Index: RAVLT, *r* = -.22; WCST*, r* = .29; *Concurrent:* DRS: *r* = .81 (Malec & Thompson, 1994), *Predictive*: living status at 1 yr follow-up (*r* = .64)(Malec, 2001; Malec & Thompson, 1994).	Well-refined scale. Designed for ABI. Subscales reflect key areas of global function Clinician, informant and self-rated versions. Highly responsive to change (d = 1.71) following treatment (Malec, 2001).	No inter-rater or test-retest reliability estimates.

Note. R = Early recovery, I = Intervention Studies, O = Outcome Studies, C = Core, B = Basic, S = Supplemental, E = Emerging, Δ = sensitive to change. N = not enough evidence; N/A = not available. DRS =Disability Rating Scale; ICC = Intraclass Correlation; NRS = Neurobehavioural Rating Scale; WCST = Wisconsin Card Sorting Test; RAVLT= Rey Auditory Verbal Learning Test.

Table s1b.

Recommendations for Communication Instruments

Test	ICF	Type of Study			Δ	Psychometrics	Strengths	Weaknesses
		R	I	O				
Western Aphasia Battery-Revised; Aphasia Quotient	b167	S	S	S	✓	<u>*Reliability*</u>*:* <u>*Internal consistency*</u>*:* (α =.91), *intra-rater and inter-rater reliability*, and *test-retest* reliability are all high. <u>*Validity*</u>*:* WAB-R and Neurosensory Centre Comprehensive Examination for Aphasia are highly associated (*r* = .96)(Kertesz, 2007)	Detects aphasia; may be used in early recovery; widely known and available; Aphasia quotient is useful to determine aphasia type; useful for pre and post assessment; separate forms for auditory vs reading skills; easy to use. Sensitive to change.	Does not measure high-level language problems; no data for TBI; ceiling effects for most people with TBI; objects required for assessment; can be overused and used inappropriately.

Frenchay Dysarthria Assessment-2 Edition	b167	S	S	S	✓	*Reliability*: Inter-*rater* and *intra-rater reliability* across studies is acceptable (Enderby & Palmer, 2008). Inter rater reliability was fair to moderate (r = .38-.77); intra rater reliability was high (r = . .72 - .92). *Validity: FDA-2 predicted correct diagnostic dysarthria category in 90% of cases when compared to neurology and imaging results* (Enderby & Palmer, 2008).	Quick and easy to administer; improved reliability over the original version; enables type and degree of dysarthria to be determined along with the severity of the contributing factors which guides treatment; has been translated into other languages including Arabic; intelligibility section is sensitive to change (Bowen et al., 2012) and sensitive to change with TBI communication recovery (Togher et al., in prep).	The revised version has received limited use in a TBI sample.

Boston Naming Test 2nd ed. Short Form (BNT-S)	b167	S	S	S	✓	Reliability: Internal consistency: α =.72, Construct validity: correlates with full version: *r* = .91; identified 38% of patients with dementia as abnormal with naming compared to 44% using the full version, α = .90 (Graves, Bezeau, Fogarty, & Blair, 2004).	Widely used; correlates with other common neuropsychological tests; well known across different disciplines; good psychometrics; Simple to administer - clear instructions provided in manual; Good accessibility; sensitive to change.	Norms out of date and limited to U.S.; culturally specific items; unknown sensitivity to mild-moderate TBI; items often not suitable for younger TBI clients; not sensitive to mild word finding that affects fluency; sensitive to education, vision problems.
Functional Assessment of Verbal Reasoning and Executive Strategies (FAVRES)	b164, b167	N	S	S	N	Inter-rater reliability: k = .81- .85. Sensitivity and specificity: sensitivity = .88 and specificity = .83. Concurrent validity: differentiates between adults with and without ABI (MacDonald & Johnson, 2005) including mTBI (Parrish, Roth, Roberts, & Davie, 2009). Predictive: Employment status of people with severe TBI was strongly correlated with	Ecologically valid; unique tool for assessing complex, verbal reasoning activities resembling daily life. Can administer single subtests; examines higher-level cognitive linguistic skills that are not captured using other standardised tests; good	Lengthy (20 min limit per subtest); can be difficult for novice clinicians to use; little natural discourse; North America based; test forms are expensive, a number of printed resources are required to complete the assessment; print is small for clients with visual impairments.

						FAVRES (Rietdijk, Simpson, Togher, Power, & Gillett, 2013).	accessibility - Available in most TBI units clinically.	
Adapted Kagan Scales for TBI Interactions; Support in Conversation and Participation in Conversation	d3, b167	S	S	S	✓	*Reliability: Inter-rater:* MSC (ICC = .85–.97); MPC (ICC = .84–.89). *Intra-rater agreement*: (MSC: ICC: .80–.90; MPC: ICC: .81–.92)(Togher, Power, Tate, McDonald, & Rietdijk, 2010). *Construct validity*: Original scales: Correlation b/w clinical judgements and MPC and MSC ratings and 2 raters (rater 1: rho: .87-.95, rater 2: rho: .83 -.88) (Kagan et al., 2004b).	The Adapted MPC and MSC scales is a new way of examining communication partner contributions to TBI interactions, as well as the participation of the individual with TBI. Sensitive to change following intervention (Togher, McDonald, Tate, Power, & Rietdijk, 2013).	Complex scale – requires training – up to approximately 10 hours to achieve reliability.
Profile of Pragmatic Impairment in Communication (PPIC)	d3, b167	S	S	S	✓	*Reliability: Inter-rater*: ICC: (one rater) .43 -.64 (2 raters); .75-.88. Validity: *Concurrent:* 10 summary scores were significantly associated with group membership (poor vs good social skills), *r* = .58-.97. (Linscott, Knight, & Godfrey, 1996)	Designed specifically for use with people with TBI, based on principles of social communication, comprehensive and sensitive to changes in varied	Scoring is subjective. However, averaging scores of 2 independent raters minimises the effect of any potential bias on the part of a rater.

							pragmatic skills following treatment (Dahlberg et al., 2007).	
Discourse Tasks (TBI Bank Protocol)	d3, b167	S	S	S	N	*Reliability: Inter-rater* across studies is acceptable (Coelho et al., 2005). *Validity:* Story narrative measures correctly classified 64.5% of those with a TBI and 74.4% of those without (Coelho, Youse, Le, & Feinn, 2003).	Addresses need for functional, context-sensitive assessment; assesses high level cognitive linguistic skills; can be repeated; simple; non-invasive way to screen, e.g. during PTA; flexible, e.g. discussion with family can be recorded; reflects everyday communication; easy to administer; analysis techniques are extensively reported.	Analysis procedures not standardised; transcription and analysis is time consuming so clinicians may rely upon subjective evaluation; lacks normative data; may be difficult to interpret; analysis depends on level of experience; Inter-rater agreement difficult to establish; results may be ambiguous if performed in isolation.

LaTrobe Communication Questionnaire (LCQ)	d3, b167	S	S	S	✓	Reliability: *Internal consistency*: Normative sample: Self-report: α = .85; IR: α = .86; TBI sample: Self-report: α = .91; Informant-report α = .92; *Test-retest reliability*: normative sample: *r* = .76 (SR), *r* = .48 (IR): TBI sample: *r* = .81 (SR), *r* = .87 (informant report)(2 weeks). *Validity: Concurrent*: LCQ is associated with executive function deficits (Douglas, 2010) and deficits in social perception (Watts & Douglas, 2006).	Good psychometrics and good stability in the TBI sample; free; involves both self-report and informant-report; taps communication in a natural context and verbal and non-verbal skills; can be repeated; sensitive to range of communication difficulties; easy to administer and score; uses everyday language. Sensitive to improvement with treatment (Togher, McDonald, Tate, Rietdijk, & Power, 2016)	Lengthy for a questionnaire; often a clinician is required to help complete it; scoring polarity changes through form; questions can be wordy while there is limited normative data (Douglas, Bracy, & Snow, 2007) there are no cut-offs for impairment.

Note. R = Early recovery, I = Intervention Studies, O = Outcome Studies, C = Core, B = Basic, S = Supplemental, E = Emerging, Δ = sensitive to change. N = not enough evidence; N/A = not available. ICC = intraclass correlation; mTBI = mild traumatic brain injury.

Table s1c.

Recommendations for Social Cognition Instruments

Test	ICF	Type of study			Δ	Psychometrics	Strengths	Weaknesses
		R	I	O				
The Awareness of Social Inference Test (TASIT) & The Awareness of Social Inference Test-Short (TASIT-S)	b122, d7	S	S	S	✓	*Reliability: Test-retest:* Part 1: *r* = .74; Part 2: *r* = .88; Part 3: *r* = .83 (1 week); *Alternative form:* Part 1: *r* = .83; Part 2: *r* = .62; Part 3: *r* =.78 (5-26 weeks); *Internal Consistency*: Short version: Rasch item reliability estimates all > .89; item infit and outfit values within the optimal range (.74-1.21). *Validity: Convergent*: TASIT correlates with IQ, WAIS-III SS, DS & LNS, TMT and socially orientated tasks of new-learning and executive processing as well as experimental social tasks. *Divergent*: no correlation with most non-social EF and learning tasks (McDonald et	Is an ecologically valid test of social cognition; good psychometrics; can be administered by a non-psychologist; measures various aspects of social cognition including emotion perception and more complex (higher order) social cognition; no similar measures currently available; has been used extensively in TBI research; can be sensitive to treatment (Bornhofen &	Full version is lengthy to administer (about 60 to 85 minutes for TBI people); must be purchased and is expensive; based on Australian culture and Australian English. Thus may not be applicable to other cultures, although numerous translations have been made. The short version does not assess all categories of emotion;

						al., 2006); *Construct*: Short version Highly correlated with original (all *r*'s > .87; Honan et al., 2016). *Concurrent:* TASIT can discriminate TBI participants and normal controls and correlates to poor social communication in vivo (Honan et al., 2016; McDonald & Flanagan, 2004; McDonald, Flanagan, Martin, & Saunders, 2004; McDonald et al., 2003).	McDonald, 2008). The TASIT-S is a good brief alternative to the full TASIT.	
Interpersonal Reactivity Index (IRI)	b122, d7	S	S	S	N	*Reliability: Internal consistency:* α = .70-.78 (Davis, 1983); Test-retest: ICC: .61-.81 (Davis, 1980); *Validity: Convergent/divergent*: PT and Hogan Empathy (cognitive empathy) scale: *r* = .40, EC scale less (*r* = .18), EC and Mehrabian and Epstein Emotional Empathy Scale (*r* = .60) and PT scale less (*r* = .20). *Concurrent:* Higher PT scores associated with better social functioning (*r* = -.15) and higher self-esteem (*r* = .23), but not related to intellectual ability.	Measures cognitive and emotional empathy; has been used widely and in TBI research; psychometric properties are ok, although weak with respect to PD and FS; brief, quick to administer; free to download: http://www.eckerd.edu/academics/psychology/iri.php;	Requires a reasonable level of English skills to complete. Subjective (i.e. self-report) measure, thus it is possible that some may lack insight into their empathy difficulties. There is argument that the scales confound other attributes (such as sympathy). PD and FS scales (Baldner & McGinley, 2014). As research into empathy continues,

	(Davis, 1983). IRI can distinguish between moderate to severe TBI and control participants (Bivona et al., 2014; de Sousa et al., 2010).	refined notions of empathy may make the IRI redundant.

Note. R = Early recovery, I = Intervention Studies, O = Outcome Studies, C = Core, B = Basic, S = Supplemental, E = Emerging, Δ = sensitive to change. N = not enough evidence; N/A = not available. DS = Digit Span; EC = Empathetic Concern; EF = Executive Function; FS = Fantasy Scale; FSIQ = Full Scale Intelligence Quotient; ICC = Intraclass Correlation; LNS = Letter-Number Sequencing; PD = Personal Distress; PT = Perspective Taking; SS = Symbol Search; WAIS = Wechsler Adult Intelligence Scale.

Table s1d.

Recommendations for Behavioural and Executive Function Instruments

TEST	ICF	Type of study			Δ	Psychometrics	Strengths	Weaknesses
		R	I	O				
Overt Behaviour Scale (OBS)	b130, b164	S	S	S	✓	*Reliability: Inter-rater and Test-retest*: .97 and .77, respectively. *Construct validity*: Convergent: MPAI, CBS, NRS behavioural subscales: moderate-strong coefficients (.37–.66); Divergent: no correlation with other sub-scales of these tools. (Kelly et al., 2006)	Comprehensive assessment of challenging behavior; good psychometric properties; widely used; free; quick (being retrospective): sensitive to change following intervention (Kelly et al., 2006).	Only includes one item on deficiencies in behavior (initiation); a complex scale so needs time and practice on administration and scoring.
Dysexecutive Questionnaire (DEX)	b130	S	S	S	N	*Reliability: Internal consistency:* >.90; Inter-rater reliability: *r* = .79 (Bennett, Ong, Ponsford, 2005a; Bennett, Ong, Ponsford, 2005b). Construct validity: 3-5 factors (Simblett & Bateman, 2011); correlates with	A brief measure of self-reported and other-reported EF difficulties. Covers several domains of EF.	Seems to measure a series of related constructs, rather than one single construct without agreement as to factor structure. Total change score estimations may be misleading.

						measures of EF (Bennett et al., 2005a; Bennett et al., 2005b; Burgess, Alderman, Evans, Emslie, & Wilson, 1998), lower correlations with dissimilar constructs: e.g. RBMT, *r* = .06 (Burgess et al., 1998).		The questionnaire must be purchased in conjunction with the BADS.
Behaviour Rating Inventory of Executive Function-Adult (BRIEF-A)	b130, b164	S	S	S	N	Inter-rater reliability: Self (SR) vs Informant (IR): moderate correlations (.44-.68). Internal consistency: SR: scales (.73-.90), indexes/overall score (.93-.96). IR: .80-.98 across scores. Factor analysis of SR and IR forms yielded 2-factors accounting for 73% and 76% of the variance, respectively. Test-retest reliability: SR; *r* = .82-.94 (4.22 weeks). Informant Report, *r* =.91-.96. Construct validity: BRIEF and FrSBe subscale EF: r = .63-.74 (SR) .68-.74 (IR). DEX and BRIEF subscales BRI (.84), MI (.73) and GEC (.84).	Brief; covers aspects of EF and provides T-scores for each scale; strong psychometric properties; reasonable price; does not require training to administer and score.	Must score by hand unless purchase computer scoring program; Validated in U.S. normative sample only.

	Discriminates between people with and without TBI. (Roth et al., 2005)	

Note. R = Early recovery, I = Intervention Studies, O = Outcome Studies, C = Core, B = Basic, S = Supplemental, E = Emerging, Δ = sensitive to change. N = not enough evidence; N/A = not available. BRI = Behavioural Regulation Index; CBS = Current Behaviour Scale; EF = executive function; FrSBe = Frontal Systems Behaviour Scale; GEC = Global Executive Composite; MI = Metacognition Index; MPAI = Mayo-Portland Adaptability Inventory; NRS = Neurobehavioural Rating Scale; RBMT = Rivermead Behavioural Memory Test; SR = Self-report; IR = Informant Report.

Table s1e.

Recommendations for Other Neuropsychological Functioning Instruments

Test	ICF	Type of study			Δ	Psychometrics	Strengths	Weaknesses
		R	I	O				
Shipley-2	b117, b164	S	S	S		*Reliability: Internal Consistency:* Composite A (Vocabulary (V) & Abstraction (A) α:.88-.97; Composite B (V & Block Patterns (BP)) α: .91-.95. V only α: .85-.92; *Test-Retest: r* =.74 -.94 (4 weeks). *Validity: Construct*: Fluid subtests correlate with each other highly (.61) and lower with V (crystallised ability) (.38- .49). Correlates with WAIS-III VIQ, PIQ and FSIQ (.62-.87). *Concurrent:* Discriminates between clinical and non-clinical adults (*effect size* = .75 – 1.37)(Shipley et al., 2009).	Provides a quick estimate of cognitive ability. Impairment Index may be a more useful tool for premorbid function than the NART or other reading tests; multiple choice format (V and BP) and short written responses of no more than 6 letters or numbers (Abstraction).	If administering WAIS-IV will tap similar abilities; No psychometric properties for the Impairment Index or correlations with WAIS-IV FSIQ estimates.

Wechsler Adult Intelligence Scale-IV (WAIS-IV); Digit Span	b140	S	S	S	*Reliability:* *Test-retest*: DSF, DSB and DSS: *r* = .71 to .77. (22 days); *Inter-rater:* *r* = .98 to .99. *Internal reliability*: split-half: DSF = .84; DSB = .78; DSS = .89. *Validity:* *Construct*: WAIS-IV VCI and its subtests correlate with Letter and Category Fluency of the D-KEFS. *Concurrent*: DSS, but not DSB and DSF discriminates moderate to severe TBI from matched controls. (Wechsler, 2008)	Well known neuropsychological measure; most common test of neuropsychological function; well used in research; strong psychometric properties; well-normed; efficient in terms of administration time; clear instructions to ensure high rates of inter-rater reliability.	Part of an expensive battery; cannot be administered by non-psychologists; administration of the full WAIS-IV is time-consuming; no parallel versions of the test.
WAIS-IV; Processing Speed Index (PSI)	b147	S	S	S	*Validity:* *Construct*: PSI highly correlated with D-KEFS Trail-Making completion time scores in moderate to severe TBI participants. *Concurrent*: Index discriminates moderate to severe TBI from matched controls. (Wechsler, 2008)	As above	As above
Wechsler Memory Scale-IV (WMS-IV); Logical	b144	S	S	S	*Reliability:* *Internal Consistency*: (normal adults): LM I α = .82; LM II: α = .85 for LM II. Adults with TBI: LM I: α = .88; LM II: α = .93.	Quick and easy to administer. Norms for countries other than USA available; strong	Need to purchase entire WMS-IV; expensive; heavily reliant on verbal

Memory I & II (LM I & LM II)					*Test-retest*: LM I: *r* = .72; LM II: *r* = .67 (23 days); *Validity: Construct*: correlates with CVLT II Short delay free recall (.40-.47), CVLT II long delay free recall (.45-.52), RBANS Immediate Memory Index (.53-.57) and RBANS Delayed Memory Index (.28-.49); *Concurrent*: Impaired performance in individuals with TBI (Wechsler et al., 2009).	psychometric properties; well established measure of structured verbal memory.	abilities therefore not suitable for individuals with language disorders.
Rey Auditory Verbal Learning Test (RAVLT)	b144	S	S	S	*Reliability: Test-retest:* Total recall: *r* = .60-.70 (1 year) (Mitrushina, Satz, Chervinsky, & D'Elia, 1991), *r* = .55 (Snow, Tierney, Zorzitto, Fisher, & Reid, 1988); *Internal reliability*: Total score: α > .90) (van den Burg & Kingma, 1999). *Validity:* extensive literature regarding good construct, criterion and predictive validity (Strauss, 2006).	Good floor and ceiling effects. Extensive norms including Australian norms (Carstairs, Shores, & Myors, 2012); used extensively in clinical practice; assesses immediate and delayed memory.	Can be lengthy to administer (25-30 mins); poor test-retest reliability means that test results need to be interpreted with caution and sensitivity to change may be less than optimal.
Trail-Making Test (TMT)	b140, b164	S	S	S	*Test-retest reliability:* TMT A and B: (24-36 hours): *r* = .83 and .90 (DesRosiers &	Easy to administer; clinical training unnecessary; has	Practice effects, particularly Trails B; can be confusing/frustrating for

					Kavanagh, 1987); 3 weeks to 1 year: *r* = .36-.79 and *r* = .44 -.89 (Dikmen, Heaton, Grant, & Temkin, 1999). *Alternative-forms*: *r* = .79-.88 (DesRosiers & Kavanagh, 1987). *Validity: Construct*: TMT in people with TBI most dependent on Rapid Visual Search and Visuomotor sequencing (DesRosiers & Kavanagh, 1987). In normal participants, TMT B reflects working memory and switching ability (Sanchez-Cubillo et al., 2009); *Concurrent*: Clearly differentiates people with TBI from control groups (DesRosiers & Kavanagh, 1987).	normative information; free; assesses processing speed and cognitive flexibility; has parallel versions; has been tested at sites in North America, United Kingdom, Australia, Europe.	participants who are very cognitively impaired. May have task non-completion which must be dealt with statistically (e.g., set a maximum time for non-completers); does not indicate specific impairment, this needs to be interpreted; performance must be closely monitored to accurately score errors. Reliability of test administration affected by examiner's reaction time in noticing errors and pointing them out. More severe motor impairment may influence results.
Controlled Oral Word Association Test (COWAT) & Animal Naming	b164	S	S	S	*Reliability: Internal consistency:* α.83 for F,A,S (Tombaugh, Kozak, & Rees, 1999) and .83 for C,F,L (Ruff, Light, Parker, & Levin, 1996). *Test-retest reliability:* typically over .70 for both	Users may design their own materials; norms available in compendiums e.g. (Strauss, 2006); quick to administer;	Low specificity; abilities underlying performance on the test are varied (attention, working memory, processing speed, episodic memory),

	letter and semantic fluency (1 week-5 years) (Basso, Bornstein, & Lang, 1999; Dikmen et al., 1999; Tombaugh et al., 1999). *Validity:* *Construct*: Letter fluency and VIQ (*r* = .44 - .87), Semantic fluency and BNT (*r* = .57-.68)(Henry & Crawford, 2004). *Concurrent*: people with TBI patients were impaired compared to healthy controls: clear relationship with severity across mild, moderate and severe classifications (Henry & Crawford, 2004).	sensitive to TBI and predicts severity; strong psychometric properties.	thus it is difficult to attribute impairment to a particular cognitive function; highly influenced by premorbid VIQ.

Note. R = Early recovery, I = Intervention Studies, O = Outcome Studies, C = Core, B = Basic, S = Supplemental, E = Emerging, Δ = sensitive to change. N = not enough evidence; N/A = not available. CVLT II = California Verbal Learning Test II; D-KEFS = Delis–Kaplan Executive Function System; DS = Digit Span; DSF = Digit Span Forward; DSB = Digit Span Backward; DSS = Digit Span Sequencing; FSIQ = Full Scale Intelligence Quotient; ICC = Intraclass Correlation; LNS = Letter-Number Sequencing; NART = National Adult Reading Test; PIQ = Performance Intelligence Quotient; RBANS = Repeatable Battery for the Assessment of Neuropsychological Status; SS = Symbol Search; VIQ = Verbal Intelligence Quotient; WAIS = Wechsler Adult Intelligence Scale.

Table s1f.

Recommendations for Psychological Status Instruments

Test	ICF	Type of study			Δ	Psychometrics	Strengths	Weaknesses
		R	I	O				
Alcohol Use Disorders Identification Test (AUDIT)	b1303, e110	S	S	S		*Reliability: Internal Consistency:* α = .93. (Reinert & Allen, 2002); *Test-retest: r* = .81 (6 weeks)(Daeppen, Yersin, Landry, Pecoud, & Decrey, 2000); *r* =.81 (2 weeks)(Lennings, 1999): *Validity: sensitivity and specificity*; .88 and .87, in people with TBI (using cut-off score of 11) (Bryce, Spitz, & Ponsford, 2015).	Has been used widely and recently validated in TBI population as a screening instrument. * NB Not designed to measure treatment outcomes.	Not appropriate for use within 12 months of injury as questions relate to the past year. Medical advice to abstain from alcohol following injury may confound responses, with scores not reflecting subsequent or typical patterns of consumption.
Drug Abuse Screening Test (DAST)	b1303, e110	S	S	S		*Reliability: Internal consistency*: α: DAST-28: .92-.94; DAST-20: .74–.95. *Test-retest:* DAST-28: *r* = .85 (2 weeks) (El-Bassel et al., 1997); *r* =.78; DAST-10, *r* = .71 (psychiatric sample)	The scale has been used in previous research to examine alcohol use following TBI (Bryce	Dichotomised items do not operationalise patterns of drug use, e.g. frequency or severity.

						(Cocco & Carey, 1998); *Validity*: *Convergent*: DAST-20 correlates with DAST-28 and with other alcohol, drug, and psychiatric indices (Cocco & Carey, 1998) (Cocco & Carey, 1998). Sensitivity and specificity of the recommended cut-off score of 6 for the DAST was 75% and 100% respectively in people with TBI (Bryce et al., 2015).	et al., 2015); brief to administer; a highly face-valid instrument.	
Hospital Anxiety and Depression Scale (HADS)	b152	S	S	S	✓	*Reliability: Internal* consistency: HADS-A; α = .94; HADS-D: α = .88 (Whelan-Goodinson, Ponsford, & Schönberger, 2009). *Test-retest (*adolescent sample): HADS-A: *r* =.74; HADS-D: *r* = .62 (2 weeks) (White, Leach, Sims, Atkinson, & Cottrell, 1999). *Validity: Internal* – In TBI, a two-factor solution is supported (Schönberger & Ponsford, 2010). *Convergent:* In a TBI cohort: large and significant correlations between corresponding HADS	Has relatively few items reflecting injury/illness-related symptoms, apart from cognitive slowing: quick to administer; has been extensively used in TBI studies and validated against the SCID (First, Spitzer, Gibbon, & Williams, 2002) and DASS (Lovibond & Lovibond, 1995). Has shown responsiveness to change	Measures symptoms in past week only; must be purchased.

						and DASS scales (both *r* = .76). *Divergent:* Correlations with discriminant measures also large with *r* = .70 between DASS-D and HADS-A, and *r* = .59 between DASS-A and HADS-D (Dahm, Wong, & Ponsford, 2013). *Sensitivity* (using 7/8 cut-off in a TBI sample): HADS-A: .75; HADS-D: .62; *Specificity:* HADS-A: .69; HADS-D: .92. (Whelan-Goodinson et al., 2009)	in intervention studies (e.g. Turk et al., 2015).	
Beck Hopelessness Scale (BHS)	b152	S	S	S	✓	*Reliability*: *Internal consistency*: Cronbach α: .93. *Interrater reliability*: *r* = .86. *Validity*: *Concurrent validity* with clinical ratings of hopelessness in a general practiced sample: *r* = .74, in a hospitalised sample with suicide attempts: *r* = .62; with Stuart Future Test: *r* = .60. *Construct validity*: factor analysis identified three components (Affective, Motivational, Cognitive).	Responsiveness demonstrated in a TBI sample in an RCT targeting hopelessness (Simpson, Tate, Whiting & Cotter, 2011)	Must be purchased.

Beck Scale of Suicidality (BSS)	b152	S	S	S	N	*Reliability*: *Internal consistency*: Cronbach α: .84-.89 (Beck et al., 1979; Beck, Brown, & Steer, 1997). Interrater reliability: *r* = .83. *Validity*: *Concurrent validity* with the Beck Depression Inventory: *r* = .39; with Beck Hopelessness Scale: *r* = .47. *Discriminant validity*: significant differences in scores between patients hospitalised for suicide ideation and outpatients being treated for depression. *Construct validity*: factor analysis identified five components (Intensity, Active Desire, Planning, Passive Desire, Concealment). (Beck et al., 1979)	Widely used in suicide prevention research. Good psychometric properties.	Must be purchased.
Brain Injury Questionnaire of Sexuality (BIQS)	b640, d7702	S	S	S	N	*Reliability*: *Internal consistency*: Cronbach α: .92 (total score); subscales range .81-.94 (Stolwyk et al., 2013). *Concurrent validity* with Derogatis Interview for Sexual Functioning – Self-report (DISF-SR): 2 BIQS factors show	Good psychometric properties. Developed specifically for individuals with brain injury. Freely available in the published literature.	Mood subscale contains only 2 items and therefore may lack reliability. Scores are relative to pre-injury only.

						moderate correlations with subscales of DISF-SR (BIQS Sexual Functioning with DISF-SR Orgasm *r* = .68, Drive/Relationships *r* = .64, Sexual Arousal *r* = .44, Sexual Behaviour/Experiences *r* = .32; BIQS Relationship Quality and Self-Esteem with DISF-SR Orgasm *r* = .42, Drive/Relationships *r* = .38) (Stolwyk et al., 2013). *Discriminant validity*: significant differences in scores between TBI and normal control groups (Downing, Stolwyk, & Ponsford, 2013).		
Impact of Life Events Scale-Revised (ILES-R)	b152, d240	S	S	S	✓	*Reliability: Internal Consistency:* α: Intrusion: .87-.94, Avoidance: .84-.87, Hyperarousal: .79-.91 (Creamer, Bell, & Failla, 2003). *Test-retest*: *r* = .89-.94 (6 months)(Weiss & Marmar, 1996). *Validity*: *Construct*: 3 scales upheld in car accident survivors; *Convergent*: PTSD Scale: *r* = .39-.66; PTSD Symptom Scale:	Short, easily administered and score correlates with the DMS-IV criteria for PTSD; can be used repeatedly to assess progress; has been translated into many languages; has been used in PTSD intervention study involving mild	A screening tool rather than a comprehensive test; has a non-clinical focus; best used for recent not remote traumatic events.

	r = .60-.86; STAI: *r* = .45-.70; BAI: *r* = .58-.70. *Divergent:* negligible correlations with the Marlowe-Crowne Social Desirability Scale (*r* = -.01 to .05); *Concurrent*: subscales were able to discriminate between those with PTSD and those without PTSD (Beck et al., 2008). Sensitivity and specificity: Using cut-off of 34 to detect PTSD; sensitivity: .86-.89; specificity: .74-.80 (Morina, Ehring, & Priebe, 2013).	TBI cases (Bryant, Moulds, Guthrie, & Nixon, 2003).

Note. R = Early recovery, I = Intervention Studies, O = Outcome Studies, C = Core, B = Basic, S = Supplemental, E = Emerging, Δ = sensitive to change. N = not enough evidence; N/A = not available. DASS= Depression, Anxiety and Stress Scale; HADS-A = HADS Anxiety; HADS-D = HADS Depression; SCID = Structured Clinical Interview for DSM-IV; BAI = Beck Anxiety Inventory; STAI = State and Trait Anxiety Index; PTSD = Post Traumatic Stress Disorder.

Table s1g.

Recommendations for TBI-Related Symptoms Domain

Test	ICF	Type of study			Δ	Psychometrics	Strengths	Weaknesses
		R	I	O				
Epworth Sleepiness Scale (ESS)	b134	S	S	S	✓	*Reliability: Internal consistency*: α = .88, and in a factor analysis, only one factor was detected (Johns, 1991). Numerous studies using the ESS have supported high validity and reliability.	Measures an important consequence of TBI; has reasonable psychometric properties; translated into a number of languages. Sensitive to treatment (Sinclair, Ponsford, Taffe, Lockley, & Rajaratnam, 2014).	As a subjective measure is less sensitive to sleepiness than objective measures (e.g. Multiple Sleep Latency Test).
Pittsburg Sleep Quality Index (PSQI)	b134	S	S	S	✓	*Reliability: Internal consistency:* α = .83 for its seven components. *Test-retest: r* = .87 (Backhaus, Junghanns, Broocks, Riemann, & Hohagen, 2002). *Validity: Construct*:	Has been used extensively in the TBI population in recent years. Is sensitive to a range of	Association between self-reported sleep quality and objectively measured sleep on polysomnography is not strong.

						correlation with sleep diary: *r* = .63- .80. *Concurrent:* 94% agreement with DSM-IV diagnosis of insomnia, 100% sensitivity and 96% specificity (Fictenberg et al., 2001).	interventions to improve sleep (Yang et al., 2015).	
Fatigue Severity Scale (FSS)	b130	S	S	S	✓	*Reliability: Internal consistency*: α = .81-.94 across clinical and normal samples including TBI (Ziino & Ponsford, 2005); *Test-retest: r* = .81-82 (Armutlu et al., 2007; Taylor, Jason, & Torres, 2000). *Validity: Convergent*: highly correlated with both Visual Analogue Scale scores (*r* = -.76) and the SF-36 (*r* = -.76) (Taylor, Jason, & Torres, 2000); *Concurrent:* negatively associated with cognitive and physical functioning; *r* = -0.41,-0.48, respectively (LaChapelle & Finlayson, 1998); discriminates between fatigued and non-fatigued patients with brain injury of mixed	Sensitive to change with time and treatment (Dittner, Wessely, & Brown, 2004; Sinclair et al., 2014); used in numerous studies of TBI; self-report; easy to administer; can be completed quickly with minimal effort.	Has floor and ceiling effects; less precise in measuring both low and high levels of fatigue, compared with the MFIS; Overall score can distinguish between groups but individual questions cannot; 7-point Likert scale may obscure the distinction between categories (collapsing to three categories may be better).

						aetiology (LaChapelle & Finlayson, 1998; Taylor et al., 2000).		
Modified Fatigue Impact Scale (mFIS)	b130	S	S	S	N	*Reliability:* *Internal consistency*: α: all items: .97: Cognition subscale: .95; Physical subscale: .96. (Schiehser et al., 2015). *Test-retest:* ICC = .85 in people with MS (Rietberg, Van Wegen, & Kwakkel, 2010). *Validity*: *Construct* (mTBI): 2 factors identified – Cognitive (11 items) and Physical (10 items) (Schiehser, 2014). *Convergent:* (people with MS) correlation with Fatigue Severity Scale: r = .66 (Rietberg et al., 2010); *Divergent*: does not diverge from the BDI: Spearman r = .70 (Tellez et al., 2005).	Freely available; relatively quick to complete with only 21-items; high face-validity; measures both physical and cognitive aspects of fatigue.	MFIS cannot be used to generate a single overall score of fatigue. The conceptual interaction between the two dimensions remains unclear, which poses problems when interpreting change scores in these individual scales.

Note. R = Early recovery, I = Intervention Studies, O = Outcome Studies, C = Core, B = Basic, S = Supplemental, E = Emerging, Δ = sensitive to change. N = not enough evidence; N/A = not available. BDI = Beck Depression Inventory; DSM-IV = Diagnostic and Statistical Manual of Mental Disorders 4th Edition; ICC = Intraclass Correlation; MS = Multiple Sclerosis; mTBI = Mild TBI.

Table s1h.

Recommendations for Activities and Participation Instruments

TEST	ICF	Type of Study			Δ	Psychometrics	Strengths	Weaknesses
		R	I	O				
Craig Handicap Assessment and Reporting Technique (CHART)	d1, d2, d3, d5, d6, d7, d8, d9	-	S	S	N	*Reliability:* Inter-rater*:* ICC = *.97* (Segal & Schall, 1995). *Test-retest*: *r* = .92 (2 weeks) (Walker, Mellick, Brooks, & Whiteneck, 2003). *Validity*: *Convergent/divergent:* Higher correlations with similar constructs: Physical with FIM, *r* = .63; lower with dissimilar constructs: Economic with FIM, *r* =.05 (Segal & Schall, 1995). *Concurrent: d*iscriminates between SCI and TBI (Walker et al., 2003).	Theoretically based (on the WHO model of Handicap) Includes a cognitive independence dimension which was developed after the original version and makes it more applicable for TBI.	Originally developed for people with SCI; possible difficulty with quantifying some responses; does not measure level of dependence as well as CANS, or occupational and social function as well as SPRS.
Sydney Psychosocial	d2, d3, d4, d5,	S	S	S	✓	*Reliability: Form A vs Form B: Internal consistency:* α = .90 vs .93; *Inter-rater*: ICC: .95 vs .84. *Test-retest: r = .90 (1 month) vs .90*	Extensive and rigorous development process.	Psychometric properties largely established on original SPRS (which had a 7-point scale).

Reintegration Scale (SPRS)	d6, d7, d8, d9					*(1 week)* (Tate, Hodgkinson, Veerabangsa, & Maggiotto, 1999; Tate, Pfaff, Veerabangsa, & Hodgkinson, 2004). <u>*Validity:*</u> <u>*Convergent/divergent:*</u> scales correlate with relevant domains in SIP: *r* = -.72--.76; Lower correlations with dissimilar constructs (Tate et al., 1999).	Sensitivity to change and treatment effects. Two forms give the SPRS versatility; Informant versions particularly useful when self-report may be questionable. Sensitive to change following intervention (Simpson et al., 2004).	
Dyadic Adjustment Scale (DAS)	d710, d720, d770	S	S	S	✓	<u>*Reliability*</u>: <u>*Internal consistency*</u>: Cronbach α: .96 (total score); subscales range .73-.94. Validity: <u>*Content validity*</u>: evaluated with 3 judges. <u>*Concurrent validity*</u> with the Locke-Wallis Marital Adjustment Scale: *r* = .86 for married and r=0.88 for divorced couples; *r* = .93 for combined samples. <u>*Discriminant validit*</u>y: significant differences in scores	Reliability and validity to assess overall quality of a relationship is good (Spanier, 1988). The same form is used for both patient and informant. Publically available through the internet.	Psychometric properties have not been fully evaluated in a TBI sample. Use of subscale scores is argued to be risky for clinical diagnosis or interpretation (Spanier, 1988).

						between married and divorced couples. (Spanier, 1976)		
World Health Organisation Disability Assessment Schedule 2.0 (WHODAS 2.0)	d1, d3, d4, d5, d6, d7, d8, d9	E	E	E	N	Psychometric properties are limited and currently restricted to non-ABI populations.	Versatile administration – lots of translations, can be used across cultures.	Psychometric properties of version 2.0 not well established yet. Scoring is computerised. Does not cover anything additional to MPAI-4 and GOS-E.
Nottingham Leisure Questionnaire (NLQ)	d9	S	S	S	✓	*Reliability: Inter-rater: k* > .75 for 36/37 items; (Drummond & Walker, 1994); *Test-retest*: *r* = .86 (6 months) (Drummond, Parker, Gladman, & Logan, 2001). *Validity*: *Convergent*: associated with NEADL subtests and GHQ-12 (Drummond et al., 2001).	Leisure focus – important in brain injury population; some evidence for responsiveness in clinical trials (Drummond & Walker, 1995).	Developed on a U.K. stroke sample in the 1990s; authors caution about its use in other cultures, countries and age groups; needs normative data for the general population; items may require updating (e.g. internet/computer use is not included.

Canadian Occupational Performance Measure (COPM)	d4, d5, d6, d7, d8, d9	S	S	S	✓	Reliability: *Test–re-test* 8-weeks (*r* = .75–.86: relatives; *r* = .53–.67; self)(Jenkinson, Ownsworth, & Shum, 2007). Validity: *Convergent:* Reintegration to Normal Living Index: *r* = .72 and satisfaction change scores (*r* = .93)(Chen, Rodger, & Polatajko, 2002). *Divergent:* 5 functional measures (e.g. Bartel index) for all *r* = n.s. (Cup, Scholte op Reimer, Thijssen, & van Kuyk-Minis, 2003).	Good psychometrics, responsive to change following treatment (e.g. Doig, Fleming, Kuipers, Cornwell, & Khan, 2011). Useful for treatment/goal planning/outcome measurement. Facilitates client participation in goal planning. Used with adults and children .	Self-rated assessment tool that may be inappropriate as an outcome measure with clients with impaired self-awareness and cognitive impairment.

Note. R = Early recovery, I = Intervention Studies, O = Outcome Studies, C = Core, B = Basic, S = Supplemental, E = Emerging, Δ = sensitive to change. N = not enough evidence; N/A = not available. CANS = Care and Needs Scale; FIM = Functional Independence Measure; GHQ-12 = General Health Questionnaire-12; GOS-E = Global Outcome Scale Extended; NEADL = Nottingham Extended activities of Daily Living; SCI = Spinal Cord Injury; SIP= Sickness Impact profile.

Table s1i.

Recommendations for Support and Relationships Instruments

TEST	ICF	Type of Study			Δ	Psychometrics	Strengths	Weaknesses
		R	I	O				
The Caregiver Strain Index (CSI)	N/A*	S	S	S	N	*Reliability: Internal consistency: α:* = .90 in a long-term caregiving sample. *Test-retest: r* = .88 (2 weeks)(Thornton & Travis, 2003). *Validity: Convergent/ divergent:* Correlations with POMS anxiety scale (r= .31), Katz ADL; *r* = -.46), mental impairment (SPMSQ; *r* = .39) rehospitalisation within 2 months (*r* = .19) (Robinson, 1983).	Brief (only 13 items); in the public domain; covers various domains (financial, physical, emotional, social); robust relationship with emotional well-being.	Psychometric properties were examined in 1983 and relevance may have changed since; too few items in each domain to calculate subscale scores; only focuses on presence/absence of strain, rather than what it means to the caregiver and how they can manage it (mastery/self-efficacy).
Family Assessment Device (FAD)	N/A*	S	S	S	N	*Reliability: Internal consistency: α* = .72-.83 for subscales, *α* = .92 for general functioning. Interscale correlations: *r* = .37-.67. (Nelson et	Widespread use in TBI studies, particularly longitudinal family studies; formed basis of a large	Issues with discriminability (differences not very large); long completion time (53 items).

						al., 1989). Test-Retest: *r* = .66-.76 (1 week)(Miller et al., 1985). *Validity: Convergent:* correlations with Family Unit Inventory >.5 for 6/8 corresponding cases (Miller et al., 1985); ratings by an experienced family therapist associated with scores on corresponding dimensions of the FAD. *Concurrent:* discriminates clinical from nonclinical families (Miller et al., 1985).	literature in TBI - thus, it has the advantage of comparison across studies.	
Lubben Social Network Scale-Revised (LSNS-R)	e3	S	S	S	N	*Reliability: Internal consistency:* α = .70 (Lubben, 1988); α = .55 (Rutledge, Matthews, Lui, Stone, & Cauley, 2003); LSNS-R-12: α = .78 (Lubben & Gironda, 2004); *Validity: Construct:* three factors in the 12-item LSNS-R: (Lubben & Gironda, 2004). *Concurrent*: distinguishes dementia patients who live on their own vs in assisted accommodation (Lubben, 1988).	Focuses on structural social supports; quick and easy to administer and score; multiple domains; has (dated) normative data; has been used with TBI and other ABI populations.	Normative data required to interpret scores, but these are now dated (1988); information available on its psychometric properties are limited and also not ideal.

Social Support Survey (SSS)	e3	S	S	S	N	*Reliability: Internal consistency: α:*.97; *Test-retest:* r = .78 (1 year); *Validity: Construct:* four factors. *Convergent*: higher correlations with similar constructs (e.g., loneliness: r = .67, family functioning: r = .53). *Divergent:* lower correlation with dissimilar constructs (e.g., physical functioning r = .11). (Sherbourne & Stewart, 1991)	Carefully developed; non-overlapping constructs; multidimensional, yet brief (19 items); easily completed; face validity; focuses on function rather than structure; adequate psychometric properties in general populations.	Limited information on structural support (as intended); No clear indication about scoring procedures; not widely used in clinical (and specifically ABI) populations.
Care and Needs Scale (CANS)	e3	S	S	S	✓	*Reliability: Inter-rater*: ICC = .93-.96. *Test-retest*: 1 week: ICC = .98 (Soo et al., 2007): *Validity: Convergent:* CANS and MMSE, r = -.38; *Divergent*: CANS and SILS (premorbid ability) and NEO-FFI (personality), in both r = n.s. *Criterion*: DRS, r = .64 (at the time) r = .42 (6 months later) (Soo et al., 2010).	Excellent psychometric properties. Completed by clinician or other informant. Sensitive to those whose needs are less than daily. Sensitive to length of time a person can be left alone, and level of needs. Sensitive to changes in support needs over time (Soo et al., 2010).	Relies on clinical, subjective judgment which can affect reliability. Training required for high inter-rater reliability.

Note. * Concept not covered in ICF. R = Early recovery, I = Intervention Studies, O = Outcome Studies, C = Core, B = Basic, S = Supplemental, E = Emerging, Δ = sensitive to change. N = not enough evidence; N/A = not available. CANS = Care and Needs Scale; ICC = Intraclass Correlation; Katz ADL= Katz Activities of Daily Living; NEO-FFI = Neo Personality Index five factor Index; POMS = Profile of Mental States; SILS = Shipley Institute of Living Scale; SPMSQ = Short Portable Mental Status Questionnaire.

Table s1j

Recommendations for Sense of Self Instruments

Test	ICF	Type of study			Δ	Psychometrics	Strengths	Weaknesses
		R	I	O				
Self Awareness of Deficits Interview (SADI)	b1644	S	S	S	✓	*Reliability: Inter-rater*: Total score: ICC = .82 (Fleming et al., 1996). *Test-retest*: total score: ICC = .94 (2-4 weeks)(Simmond & Fleming, 2003). *Validity: Convergent*: with AQ: *r* = .62 (Wise, Ownsworth, & Fleming, 2005); with discrepancy index on the DEX: *r* = .40 (Bogod, Mateer, & MacDonald, 2003). *Concurrent*: predicts severity classification of TBI (mild-moderate vs severe) with 75% sensitivity and 71% specificity (Bogod et al., 2003).	Commonly used, helps investigate the aetiology of awareness deficits; sensitive to intervention (Cheng & Man, 2006); can integrate informant information to guide scoring; good face validity; client-centred tool; questions can be re-phrased and prompts provided.	Lengthy: 30-40 mins; not feasible for regular administration; problems with validity of informant reports; verbal skills and retrospective recall are likely to influence self-reported difficulties.

Patient Competency Rating Scale (PCRS)	b1644	S*	S	S	✓	*Reliability: Internal consistency:* SR: α = .91: IR: α = .93. *Test-retest*: ICC: *r* = .85 (1 week)(Fleming, Strong, & Ashton, 1998); *Validity: Concurrent*: TBI< Controls on all domains (Leathem, Murphy, & Flett, 1998); PCRS discrepancy scores correlated negatively with depression or emotional distress (Fleming et al., 1998).	Brief; publically available (COMBI site); self, relative and clinician versions; captures perceived current functioning across different domains; more refined than awareness per se. Comparison with premorbid functioning is not required. Sensitive to change over time (Fleming & Strong, 1999) and intervention (Ownsworth, Fleming, Shum, Kuipers, & Strong, 2008).	Flaw of discrepancy-based methods for awareness (does this reflect awareness deficits or relative's emotional state?); problems interpreting change over time - can arise from change in relative's score, not shifting self-perceptions of the person with TBI. The AQ is preferable except when measuring longer-term outcomes.
Head Injury Semantic Differential Scale - III (HISDS-III)	b1801, b126, b130	S	S	S	✓	*Reliability: Internal consistency: Total score:* α = .92-.93 (Carroll & Coetzer, 2011a). Test-retest (HISDS original) stable 6-months post vs 3- year follow-up) (Wright & Telford, 1996). *Validity: Convergent:* correlates with the	Theory-guided scale; brief and easy to administer; yields a range of scores; reliability and validity supported by extensive research in TBI and mixed brain injury	Ratings are likely to be influenced by language ability and retrospective recall (past self). There is a need for more research

						Frankfurt Self-Concept Scale (Doering, Conrad, Rief, & Exner, 2011), RSES and Brain Injury Grief Inventory (Carroll & Coetzer, 2011a).	samples. Sensitive to treatment (Vickery, Gontkovsky, Wallace, & Caroselli, 2006).	on sensitivity to change in response to intervention.
Tennessee Self-Concept Scale, Second Edition (TSCS-2)	b1801, b126, b130	-	S	-	✓	*Reliability: Internal consistency:* α = .73-.95. *Test-retest*: *r* = .47-.82 (manual). *Validity: Convergent*: correlated with HISDS: *r*= .72, as well as BDI-II (*r* = -.61) and QoL Inventory (*r* = .71)(Vickery, Gontkovsky, & Caroselli, 2005) and the RSES (Keppel & Crowe, 2000).	Comprehensive; measures self-concept across multiple domains; incorporates validity scores; sensitivity to change after intervention (Helffenstein & Wechsler, 1982).	Lengthy to administer; no reliability analyses have been conducted in a brain injury population.
Rosenberg Self-Esteem Scale (RSES)	b1266	S	S	S	N	*Reliability: Internal consistency:* α =.89 (Carroll & Coetzer, 2011a). *Test-retest:* ABI sample: *r* = .86 (2 weeks)(Cooper-Evans, Alderman, Knight, & Oddy, 2008). *Validity: Convergent:* correlates with depression (*r* = .65) and anxiety (*r* = .71)(Cooper-Evans et al., 2008) and negatively with positive view of	In the public domain; quick to administer; widely used, including within brain injury populations.	Does not change in response to intervention.

						self, measured using the HISDS-III, (*r* = -.365) (Carroll & Coetzer, 2011b).		
The Motivation for Traumatic Brain Injury Rehabilitation Questionnaire (MOT-Q)	PF	-	S	-	N	*Reliability: Internal consistency:* Total score: α = .91; subscales: α = .73-.86). *Validity: Convergent*: moderate relationships to a combination of MMPI variables, especially 'health concerns' scale. *Concurrent:* Adequate correlation of total score and "Lack of denial" subscore with MMPI indicators of hypochondriasis, depression, hysteria (Chervinsky et al., 1998).	Free to use; quick and easy to administer; no specific training required; specifically developed to assess motivation for post-acute rehabilitation.	Does not assess apathy or lowered motivation in other situations. Hence this is best for use in an in-patient or day-patient setting.
BIRT Motivation Questionnaire (BMQ)	PF	E	E	E	N	Reliability: *Test-retest*: 2-5 month interval (*r* = .90), Guttman split-half coefficient = .94. Interrater reliability: relationship between the BMQ-R and BMQ-S (*r* =.41). Internal consistency: BMQ-S (α = .94) and BMQ-R (α = .95). Concurrent validity: correlation between relative and self-report versions of the BMQ	Good psychometric properties; developed specifically for TBI; designed to reflect a number of components of motivational change following brain injury; needs to be administered to those at different stages of	Suitability of the tool for detecting change has yet to be established. Findings so far based on a small and possibly unrepresentative sample

	and the Apathy Evaluation Scale (r = .84 & r = .67 respectively); r = .52 with clinician's rating of motivational deficits, r = .38 between the BMQ-R and CARROT. (Oddy et al., 2001)	recovery and with different injury severity.

Note. * The brief 13 item version (Borgaro & Prigatano, 2003) is appropriate for early recovery. R = Early recovery, I = Intervention Studies, O = Outcome Studies, C = Core, B = Basic, S = Supplemental, E = Emerging, Δ = sensitive to change. AQ = Awareness Questionnaire; N = not enough evidence; N/A = not available; PF = Personal Factors, code not available. BDI-II = Beck Depression Inventory II; BMI = Body Mass Index; BMQ-R = BMQ Relative Report; BMQ-S = BMQ Self Report; CARROT = Card Arranging Reward Responsivity Objective Test; DEX= Dysexecutive questionnaire; DRS = Disability Rating Scale; ICC = Intraclass Correlation; IR = Informant Report; MMPI = Minnesota Multiphasic Personality Inventory; QoL = Quality of Life; SR = Self Report.

Table s1k.

Recommendations for Health-Related Quality of Life (Qol) Instruments

TEST	ICF	Type of Study			Δ	Psychometrics	Strengths	Weaknesses
		R	I	O				
EuroQol-5D (EQ-5D)	N/A*	S	S	S	✓	*Test-retest reliability*: good, i.e. variance attributed to "time" = 11%; variance attributed to "health state" = 82% (van Agt, Essink-Bot, Krabbe, & Bonsel, 1994).	Guidance for users; 100 translations; brief and easy; visual analogue scale useful for cognitive impairment; flexible format e.g. face-to-face, telephone, proxy; extensively used in TBI; increasingly important for health economic evaluations.	Limited assessment of mood, global in nature; overlooks some dimensions of quality of life; does not include cognition.
Satisfaction with Life Scale (SWLS)	N/A*	S	S	S	✓	*Reliability: Internal consistency:* α = .87; factor analysis suggests a single factor; *Test-retest*: 2 months: *r* =.82; Rasch analysis on	Brief; free; taps cognitive aspects; used in numerous studies. Some studies are summarised on the	More validity research needed in the context of TBI. Responsiveness to change unknown. Subjectivity as to

						777 patients with TBI (Heinemann et al: personal communication as cited in Tate, 2010): Item #5 had the poorest fit.	COMBI site. Useful complement to other QoL measures, sensitive to emotional facets of QoL. Sensitive to treatment effects (Dahlberg et al., 2007).	personal standards by which satisfaction is judged (see Tate, 2010).
World Health Organisation Quality of Life BREF (WHOQOL-BREF)	N/A*	S	S	S	✓	*Reliability: Internal consistency*: α for 4 domains .68-.82 (Skevington, Lotfy, & O'Connell, 2004), .75-.89 (non-injured); .74-.95 (TBI)(Chiu et al., 2006). Validity: Construct: Exploratory factor analysis: four factors explain 53% of variance (Skevington et al., 2004). Convergent: physical domain and GOS-E *r* = .53; psychological domain and CES-D *r* = -.64, psychological and social domain and the Social Support Survey (*r* = .52 and .37 respectively). Discriminant: Domain scores lower for TBI subjects who were	Cross-cultural; acceptable psychometric qualities; free; has brief, as well as long (100 item) form; multidimensional; extensive normative data; Assessment of environmental factors/barriers is useful and absent in other QoL measures; available in 19 languages; validated for TBI in Taiwan; sensitive to change in one study (following childbirth) (Bonomi, Patrick, Bushnell, & Martin, 2000)	Validation studies for ABI in Taiwan only; little research specific to TBI.

						unemployed, dependent in ADL and had weak social support (Chiu et al., 2006).		
Traumatic Brain Injury Quality of Life (TBI-QoL)	N/A*	S	S	S	✓	Reliability: α for each item bank > .9 (Lange, Brickell, Bailie, Tulsky, & French, 2016; Tulsky et al., 2016). Validity: *Construct*: bank items (long and short form) have acceptable goodness-of-fit (all > .91) (Toyinbo et al., 2016; Tulsky et al., 2016). Higher correlations within than between banks. *Convergent*: banks correlate with relevant measures from Neurobehavioural Symptom Inventory and PTSD Checklist (most *r* > .80). *Discriminant:* discriminates between those with mild TBI and controls (Lange et al., 2016).	First comprehensive QoL tool specifically for TBI; good psychometric techniques; normed in a large sample with TBI. Item banks common with PROMIS or Neuro-QoL so can be compared with other populations.	Not yet used in other samples and settings; sensitivity to change not yet been evaluated; reference groups differ between item banks so difficult to compare like-for-like across all domains.

Note. * Concept not covered in ICF. R = Early recovery, I = Intervention Studies, O = Outcome Studies, C = Core, B = Basic, S = Supplemental, E = Emerging, Δ = sensitive to change. N = not enough evidence; N/A = not available. ADL= Activities of Daily Living; CES-D = Centre for Epidemiologic Studies Depression Scale; GOS-E = Global Outcome Scale Extended; QoL = Quality of Life.

Table s2

Other instruments considered for recommendation (recommended instruments also noted)

Global Outcomes

8-category version of Glasgow Outcome Scale (8-GOS)
Canadian Occupational Performance Measure (COPM) (recommended for Activities and Participation)
Care and Needs Scale (CANS) (recommended for Support and Relationships)
Craig Handicap Assessment and Reporting Technique (CHART) (recommended for Activities and Participation)
Disability Rating Scale (DRS)
Functional Independence Measure (FIM) (see also Activities and Participation)
World Health Organization Disability Assessment Schedule 2.0 (WHODAS-2.0) (recommended for Activities and Participation)

Recommended:
Glasgow Outcome Scale – Extended
Health of the Nation Outcome Scales - Acquired Brain Injury Version (HoNOS-ABI)
Mayo-Portland Adaptability Inventory (MPAI-4)
Nation Outcome Scales-Acquired Brain Injury (HoNOS-ABI)

TOTAL REVIEWED = 11

Communication

AphasiaBank Repetition Test (TBI Bank Protocol)
Behaviorally Referenced Rating System of Intermediate Social Skills – Revised (BRISS-R)
Boston Naming Test, Second Edition (TBI Bank Protocol) (recommended for Other Neuropsychological Functioning)
Communication Specific Coping Scale (CommSpeCS)
Measure of Cognitive Linguistic Abilities (MCLA) (see also Other Neuropsychological Functioning)
Psycholinguistic Assessments of Language Processing and Aphasia (PALPA)
Repeatable Battery for the Assessment of Neuropsychological States (RBANS) (see also Other Neuropsychological Functioning)
Scales of Cognitive Ability for Traumatic Brain Injury (SCATBI) (see also Other Neuropsychological Functioning)
Scales of Cognitive and Communicative Ability for Neurorehabilitation (SCCAN)
Verb Naming Test from the Northwestern Assessment of Verbs and Sentences-Revised, Field Test Version (TBI Bank Protocol)
Wiig-Semel Test of Linguistic Concepts (WSTLC)

Recommended:
Western Aphasia Battery-Revised; Aphasia Quotient (TBI Bank Protocol)
Frenchay Dysarthria Assessment-2 Edition
Boston Naming Test (BNT)
Functional Assessment of Verbal Reasoning and Executive Strategies (FAVRES)
Adapted Kagan Scales for TBI Interactions; Support in Conversation and Participation in Conversation
Profile of Pragmatic Impairment in Communication (PPIC)
Discourse Tasks (TBI Bank Protocol)
LaTrobe Communication Questionnaire (LCQ)

TOTAL REVIEWED = 19

Social Cognition
Advanced Clinical Solutions(ACS) : Social Cognition
Balanced Emotional Empathy Scale (BEES)
Interpersonal Negotiation Strategy (INS)

Recommended:
Interpersonal Reactivity Index (IRI)
The Awareness of Social Inference Test - Short Form (TASIT-S)

TOTAL REVIEWED = 5

Behavioural and Executive Function
Adaptive Behavior Assessment System-II (ABAS-II) (see also Psychological Status, Activities and Participation)
Frontal Systems Behavior Scale (FrSBE)
Social Performance Survey Schedule (SPSS)

Recommended:
Overt Behaviour Scale (OBS)
Dysexecutive Questionnaire (DEX)
Behaviour Rating Inventory of Executive Function-Adult (BRIEF-A)

TOTAL REVIEWED = 6

Other Neuropsychological Functioning
Behavioural Assessment of the Dysexecutive Syndrome (BADS)
Behavior Rating Inventory of Executive Function - Adult Version (BRIEF-A) (recommended for Behavioural and Executive Function)
California Verbal Learning Test (CVLT)
Dysexecutive Questionnaire (DEX) (recommended for Behavioural and Executive Function)
Functional Assessment of Verbal Reasoning and Executive Strategies (FAVRES) (recommended for Communication)
Measure of Cognitive Linguistic Abilities (MCLA) (see also Communication)
Mini Mental State Examination (MMSE)
National Institute of Health Toolbox
Neuropsychological Assessment Battery (NAB) Screening Module
Prospective and Retrospective Memory Questionnaire (PRMQ)
Repeatable Battery for the Assessment of Neuropsychological States (RBANS) (see also Communication)
Rivermead Behavioural Memory test (RBMT)
Scales of Cognitive Ability for Traumatic Brain Injury (SCATBI) (see also Communication)
Stroop Test
Symbol Digit Modalities Test (SDMT)
The Hayling Sentence Completion Test
Wisconsin Card Sorting Test (WCST)

Recommended:
Shipley-2
Wechsler Adult Intelligence Scale-IV (WAIS-IV); Digit Span
WAIS-IV; Processing Speed Index (PSI)
Wechsler Memory Scale-IV (WMS-IV); Logical Memory I & II (LM I & LM II)
Rey Auditory Verbal Learning Test (RAVLT)
Trail-Making Test (TMT)

Controlled Oral Word Association Test (COWAT) & Animal Naming

TOTAL REVIEWED = 24

Psychological Status

Adaptive Behavior Assessment System-II (ABAS-II) (see also Activities and Participation, Behavioural and Executive Function)
Beck Depression Inventory-II (BDI-II)
Brief Symptom Inventory (BSI)
Depression Anxiety and Stress Scale (DASS) - 21 or 42
Derogatis Inventory for Sexual Functioning
Hamilton Rating Scale for Depression (Ham-D)
Nation Outcome Scales-Acquired Brain Injury (HoNOS-ABI) (recommended for Global Outcomes)
Patient Health Questionnaire–9 (PHQ-9)
Penn State Worry Questionnaire (PSWQ)
Profile of Mood States 2 (POMS-2)
State Trait Anxiety Inventory – Trait scale (STAI-T)
Symptom Checklist-90 Revised
Warwick-Edinburgh Mental Well-being Scale (WEMWBS)

Recommended:
Alcohol Use Disorders Identification Test (AUDIT)
Drug Abuse Screening Test (DAST)
Hospital Anxiety and Depression Scale (HADS)
Beck Hopelessness Scale (BHS)
Beck Scale of Suicidality (BSS)
Brain Injury Questionnaire of Sexuality (BIQS)
Impact of Life Events Scale-Revised (ILES-R)

TOTAL REVIEWED = 20

TBI-Related Symptoms

Brief Fatigue Inventory (BFI)

Recommended:
Epworth Sleepiness Scale (ESS)
Pittsburg Sleep Quality Index (PSQI)
Fatigue Severity Scale (FSS)
Modified Fatigue Impact Scale (mFIS)

TOTAL REVIEWED = 5

Activities and Participation

Adaptive Behavior Assessment System-II (ABAS-II) (see also Psychological Status, Behavioural and Executive Function)
Community Integration Measure (CIM)
Community Integration Questionnaire (CIQ)
Functional Independence Measure (FIM) (see also Global Outcomes)
Impact on Participation and Autonomy (IPA) Questionnaire
Participation Assessment with Recombined Tools-Objective (PART-O)
Social Performance Survey Schedule (SPSS) (see also Behavioural and Executive Function)

Recommended:
Craig Handicap Assessment and Reporting Technique (CHART)

Sydney Psychosocial Reintegration Scale (SPRS)
Dyadic Adjustment Scale (DAS)
World Health Organisation Disability Assessment Schedule 2.0 (WHODAS 2.0)
Nottingham Leisure Questionnaire (NLQ)
Canadian Occupational Performance Measure (COPM)

TOTAL REVIEWED = 13

Support and Relationships
Caregiver Burden Interview (CBI)
Craig Hospital Inventory of Environmental Factors (CHIEF)
Zarit Burden Interview

Recommended:
The Caregiver Strain Index (CSI)
Family Assessment Device (FAD)
Lubben Social Network Scale-Revised (LSNS-R)
Social Support Survey (SSS)
Care and Needs Scale (CANS)

TOTAL REVIEWED = 8

Sense of Self
Awareness Questionnaire (AQ)
Card Arranging
Change Assessment Questionnaire (CAQ)
Coopersmith Self-Esteem Inventory (CSEI)
Herth Hope Scale (HHS)
Percent Participation Index
Physical Self Description Questionnaire (PDQ)
Reward Responsivity Objective Test

Recommended:
Self Awareness of Deficits Interview (SADI)
Patient Competency Rating Scale (PCRS)
Head Injury Semantic Differential Scale - III (HISDS-III)
Tennessee Self-Concept Scale, Second Edition (TSCS-2)
Rosenberg Self-Esteem Scale (RSES)
The Motivation for Traumatic Brain Injury Rehabilitation Questionnaire (MOT-Q)
BIRT Motivation Questionnaire (BMQ)

TOTAL REVIEWED = 15

Health-Related Quality of Life
Quality of Life after Brain Injury (QOLIBRI)
SF-36

Recommended:
EuroQol-5D (EQ-5D)
Satisfaction with Life Scale (SWLS)
World Health Organisation Quality of Life BREF (WHOQOL-BREF)
Traumatic Brain Injury Quality of Life (TBI-QoL)

TOTAL REVIEWED = 6

Note. Italicised instruments were included in the final list of recommendation in a different psychosocial area.