A Compendium of Tests, Scales and Questionnaires

The Practitioner's Guide to Measuring Outcomes after Acquired Brain Impairment

Robyn L. Tate

A **Psychology Press** Book

A Compendium of Tests, Scales and Questionnaires

This Compendium is a comprehensive reference manual containing an extensive selection of instruments developed to measure signs and symptoms commonly encountered in neurological conditions, both progressive and non-progressive. It provides a repository of established instruments, as well as newly developed scales, and covers all aspects of the functional consequences of acquired brain impairment.

In particular, the text provides a detailed review of approximately 150 specialist instruments for the assessment of people with neurological conditions such as dementia, multiple sclerosis, stroke and traumatic brain injury. Part A presents scales examining body functions, including consciousness and orientation; general and specific cognitive functions; regulation of behaviour, thought, and emotion; and motor-sensory functions. Part B reviews scales of daily living activities and community participation. Part C focuses on contextual factors, specifically environmental issues, and Part D contains multidimensional and quality of life instruments.

Each instrument is described as a stand-alone report using a uniform format. A brief history of the instrument's development is provided, along with a description of item content and administration/scoring procedures. Psychometric properties are reviewed and a critical commentary is provided. Key references are cited and in most cases the actual scale is included, giving the reader easy access to the instrument. The structure of the book directly maps onto the taxonomy of the influential *International Classification of Functioning, Disability and Health* (World Health Organization, 2001), enabling linkage of clinical concepts across health conditions.

The Compendium will be a valuable reference for clinicians, researchers, educators, and graduate students, and a practical resource for those involved in the assessment of people with brain impairment.

Dr Robyn Tate is a clinical psychologist and neuropsychologist with more than 30 years of clinical and research experience. Her primary field of expertise is traumatic brain injury. She is currently Professor in the Rehabilitation Studies Unit, Sydney Medical School, University of Sydney, Australia where, in addition to her own clinical and research work, she is involved in the teaching and research supervision of post-graduate medical and psychology students.

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Publisher's Note
The publisher has gone to great lengths to ensure the quality of this reprint but points out that some imperfections in the original copies may be apparent.

To my father, Kevin Roy Tate (1925–2001) and
my husband, Michael Perdices with gratitude

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Foreword

This invaluable compendium fills in what has been a serious gap between clinicians' and clinical researchers' need to know screening tests and rating scales and their ready access to this information. The inspiration and the exceptionally useful contents of the book come from Dr Tate's own clinical and research work with patients whose bad luck, bad genes, or bad judgment left them with mental, behavioral, and/or physical impairments that need to be fixed or at least evaluated. This book reflects her wide-range, close and intensive clinical and research experiences and the knowledge she has gained about these patients and their needs.

Most of us working with patients whose impairments have limited their activities, their abilities or their enjoyment of life have wished we knew where to find the appropriate instruments to document these problems, follow a patient's course, plan appropriate treatment, or explain to patient and family just what the patient can and cannot do, what may help or hinder the patient's progress. Dr Tate has realized our wish in this most comprehensive, well-detailed, and thoughtfully evaluated compendium. The immediate availability of these scales and screening tests, questionnaires and inventories, will help practitioners develop and communicate the multidimensional understanding of their patients that best practices – whether clinical or for research purposes – require.

Although Dr Tate's work has been primarily in rehabilitation settings and, most specifically, with neurobehaviorally impaired patients, this compilation of behavioral, physical, and social measures will serve workers in all clinical sciences. Many of the sections of *A Compendium of Tests, Scales and Questionnaires* also have much more general applicability to every area of clinical practice and research. For example, geriatricians should find scales and inventories that are useful for monitoring their patients in Part B: Activities and Participation, which present information about "Scales assessing activities of daily living" (Chapter 7) and "Scales assessing participation and social role" (Chapter 8). And, regardless of the nature of their patients' infirmities, physical and occupational therapists will be able to make good use of the chapter written by Dr Ian Cameron, "Scales of sensory, ingestion and motor functions," which can be applicable to both their patients and their research.

Thank you, Dr Tate, for gathering and publishing for us what we've all needed and never got around to doing for ourselves.

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Preface

In one way or another, throughout my entire career I have grappled with the advantages and limitations of instruments to assess people with acquired brain impairment. When I began working as a clinical psychologist in the 1970s there was a relative dearth of assessment instruments suitable for various applications for people with acquired brain impairment. My initial appointment coincided with publication of the first edition of Muriel Lezak's *Neuropsychological Assessment* (now in its 4th edition), but unfortunately I did not learn about this invaluable resource until later. At the time, the assessment instruments at my disposal seemed insufficient to shed much light on the type of ecological prognostic questions I was expected to answer about the patients on the neurology, geriatric and rehabilitation wards of Lidcombe Hospital in Sydney. In order to achieve greater veridicality in my cognitive evaluations, I therefore developed my own comprehensive screening test, fondly referred to by my colleagues at that time as the TMFT (Tate Mental Function Test). I abandoned work on the TMFT when I discovered both Muriel Lezak's *Neuropsychological Assessment* and Kevin Walsh of Melbourne University, who kindly sent me a prepublication copy of his *Neuropsychology. A Clinical Approach*. In later years I continued revisiting instrument development to address what I saw as gaps in methods to examine psychosocial reintegration after traumatic brain injury, and to measure the even more nebulous construct of care and support needs.

In the 1970s, then, suitable instruments to assess the variety of domains of functioning pertinent to people with acquired brain impairment were limited in number, scope and relevance. Decades later the situation is at the other end of the spectrum, with the result that the clinician and researcher can be overwhelmed by the sheer volume of available tools. Such a quantum demands a comprehensive guide for the reader in the selection of the best instrument for the task at hand. The present work had its origins in a survey of the literature to identify assessment instruments to measure disability after traumatic brain injury, conducted for the Motor Accidents Authority of New South Wales by myself and Ian Cameron, assisted by Cheryl Soo. That nascent work was broadened in depth, scope and complexity for the present volume, and additionally included other neurological conditions apart from traumatic brain injury, as well as other areas of functioning apart from activity limitations.

The driving aim of this compendium has been to bring order to an increasingly diverse and complex field and to synthesize an accumulating body of knowledge so that the reader has an easy, one-step reference point for selecting and evaluating both established and newly developed screening tests, rating scales and questionnaires. A broad selection of approximately 150 instruments and their derivatives is included, which together provide a comprehensive overview of the functional consequences of all aspects of acquired brain impairment: consciousness, cognition, behaviour, motor-sensory functions, activities of daily living, social functioning and environmental factors. Additional features include a description of the instrument that is written as a stand-alone report. Each entry includes a brief history of the development of the instrument, item description, administration and scoring procedures, psychometric properties, a critical commentary and key references. Appendices are provided to enable the reader to make quick comparisons among the content of scales of activity and participation from both conceptual and clinical perspectives.

In collecting and collating the candidate measures, the objective has been to produce a compendium of assessment instruments that spans the gamut of functioning, ranging from

specific disorders of consciousness and cognition through to broad constructs of community participation. The structure of the book directly maps onto the taxonomy of the influential *International Classification of Functioning Disability and Health* (ICF), which updates and revises the older nomenclature of impairments, disabilities and handicaps. Accordingly, instruments are classified in four sections corresponding to Body Functions (formerly impairments; 5 chapters), Activities/Participation (formerly disabilities and handicaps; 2 chapters), and Contextual Factors (1 chapter). A final chapter contains multidimensional and quality of life scales that do not neatly fall within the above boundaries.

This book is written for health professionals who work with people with acquired brain impairment and is intended for clinicians, researchers, educators and advanced student trainees from a range of fields including medicine, psychology and the rehabilitation professions. The instruments included are those that are suitable for administration by generic health professionals, and tests that require special equipment or specialist training are excluded.

It goes without saying that no single volume can meet all needs and suit all purposes. In particular, publishing a book on cognitive screening tests and rating scales is not tantamount to recommending their use over detailed neuropsychological or other evaluations. With few exceptions, while the developers of all the cognitive screening tests which I reviewed for this book emphasized the limitations of such instruments for diagnostic and rehabilitation planning purposes, they agreed with me that there is a place for cognitive screening tests in acquired brain impairment, arguments that are dealt with in Chapters 1 and 3. Moreover, the present volume is best regarded as a resource, rather than a test manual. Even though the scales featured in this book are cognitive screening tests and rating scales, they vary greatly in complexity of administration and scoring procedures. For the more involved instruments, the reader will need to consult the specific test manual or original publication.

One major problem that presented itself was that of selection. Many hundreds of instruments were reviewed and considered for inclusion, and it was necessary to make decisions regarding selection of one particular instrument over another. Such decisions were not made easily and a set of criteria was established for instrument selection (see Chapter 1). Unfortunately, a number of measures with sound clinical application and good psychometric properties had to be omitted in the interests of space. An additional guiding principle for inclusion was to provide a broad array of the state of play, rather than an exhaustive coverage of a narrow field. Similarly, space dictated a word limit for each of the instruments described, and the reader is advised that this volume is intended to provide the salient psychometric properties of the instruments, rather than a detailed review of every published study. Although care was taken to identify pertinent psychometric literature, some relevant references may have been missed. The intent of including information on the psychometric properties is to enable the reader to appreciate the calibre of the scale and its suitability for various applications. Wherever possible and practical the actual scale has been included.

In reviewing instruments for this compendium, I have been acutely aware of my responsibilities to the authors whose work I am critiquing. I have endeavoured to provide a fair, balanced and informative evaluation of instruments included in the book and trust I have done justice to the authors' work. Having been at the coalface of instrument development myself, I understand only too well the time and effort that go into producing a good measure. I have learnt an immeasurable amount from my detailed study of the work of other investigators during the preparation of this book, and I am full of admiration for the expertise of many researchers whose measures I am privileged to include in this volume.

This compendium has benefited from the input of many people at various stages of its development. A multidisciplinary group of expert clinicians and clinical researchers initially gave feedback on the proposed structure of the book and the format of the entries on specific scales, and I thank Adeline Hodgkinson, Annie McCluskey, Anne Moseley, Grahame Simpson, Barbara Strettles, Leanne Togher and Mary-Clare Waugh for their suggestions. It seemed that an important and innovative angle would be to classify and unify the instruments within the conceptual framework of the ICF. A good idea – but many challenges were confronted in applying the ICF to the area of acquired brain impairment. In this daunting endeavour, helpful discussions were held with Ian Cameron, and I received advice from Ros Madden and Catherine Sykes from the

Australian Institute of Health and Welfare, Canberra, Australia, and from Alarcos Cieza from the ICF Research branch of the WHO Collaborating Center at Ludwig-Maximilian University, Munich, Germany. It was clear that if the book were to provide the breadth of evaluation relevant for people with acquired brain impairment vis-à-vis the ICF, then a necessary inclusion would be instruments to measure sensory and motor functions. Chapter 6, written by Ian Cameron, provides an essential balance to the remainder of the compendium.

When some of the entries on instruments were at draft stage, a group of graduate neuropsychology students from Macquarie University in Sydney provided helpful responses, which then guided a revised format of the entries to increase their relevance for an advanced student readership. Colleagues have provided valued feedback on pertinent chapters and special thanks are due to Ian Cameron (Chapters 1, 2, 3 and 7), Catherine Skyes (Chapter 1), Grahame Simpson (Chapter 5), Lisa Harvey and Cheryl Soo (Chapter 6), and Jennifer Fleming (Chapter 7). Ian Cameron and Grahame Simpson reviewed various additional entries on individual instruments as well. Particular thanks are due to Michael Perdices, who made a detailed and meticulous review of 9 of the 10 chapters of the book (Chapters 1–5 and 7–10), thereby also providing a comparative evaluation of the compendium as a whole. Additionally, Michael used his creativity and computer expertise to construct the wonderful "ICF trees" that appear throughout the volume.

The support and encouragement from my workplace and colleagues at the Rehabilitation Studies Unit were fundamental to the completion of this work and are appreciated. I acknowledge with gratitude the library resources of the University of Sydney and the Royal Rehabilitation Centre Sydney, as well as the invaluable help of Judith Allen and Michelle Lee. Research and administrative assistance was gratefully received at various stages over the years from James Banks, Lara Leibbrandt and Danielle Debono, along with voluntary work from Hanna Brackenreg and Shruti Venkayesh. Special thanks are due to Michelle Genders for research and administrative support over the past 18 months; her professionalism and good humour made the final stages of this book so much easier for me.

I am especially grateful to those authors and their publishers who gave permission to include their instruments, which serves to increase the usefulness of the compendium. The scales compiled in this book have been drawn from a variety of sources including scientific journals, websites and personal communication with authors. In some instances the instrument, as originally presented in a journal, was suitable for direct administration; but in other cases information was limited to item content listed in a table or appendix, or embedded in the text. This necessitated a reformatting of many scales in order that they could be readily administered, as well as providing consistency of presentation across the book. In all cases where instruments have been reformatted from the original presentation, I have endeavoured to retain the spirit of the scale. Extensive efforts were made to trace the original source of the material and obtain permission for its use from copyright holders, and if omissions have occurred the author and publisher would be pleased to receive information in order to make corrections for future editions. I also acknowledge the support of my publishers, Psychology Press, especially Rebekah Edmondson and Michael Forster; along with consultant Sharon Rubin who assisted in the permissions process. It has been a pleasure to work with the production team at Psychology Press under the expert direction of Dawn Harris, Senior Production Editor.

During the course of writing this book, I have been most fortunate in having had a supportive and steadfast band of family, friends, colleagues and graduate students, too numerous to name individually but who have cheered me along from the sidelines. The cheerleader has been my husband who, by every thought and deed, has ensured that I reached the finish line (alive and in reasonable shape). Thank you, Michael; thank you, all.

RLT
Sydney, Australia
March, 2010

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1 Introduction

Assessment after acquired brain impairment (ABI) or any other health condition is conducted for at least three main reasons: diagnosis, prognosis and evaluation (Dekker, Dallmeijer, & Lankhorst, 2005; Kirshner & Guyatt, 1985). This compendium provides a resource of assessment instruments for these purposes and the measures are described in the following nine chapters. The present introductory chapter contains three sections. First, a background to the book is provided, including the methodology used in the selection and description of the instruments. The second section describes the *International Classification of Functioning, Disability and Health* (ICF; WHO, 2001), which is the conceptual framework underlying the structure and organization of the compendium. Challenges that were encountered in placing instruments developed for ABI into the ICF framework are addressed in the final section of the chapter. The following nine chapters are grouped into four parts, which correspond in an approximate way to components of the ICF: Part A – Body Functions; Part B – Activities and Participation; Part C – Contextual Factors, specifically Environmental Factors; and Part D presents multidimensional scales – that is, instruments containing a disparate set of items crossing multiple ICF components and domains.

Background and methodology

Purpose

This compendium is intended primarily for health professionals who work with people experiencing (or at risk of) ABI. Users will include clinical practitioners in diagnostic, rehabilitation and community settings, as well as clinical researchers, educators and advanced student trainees. The main objective is to present a range of tests, scales and questionnaires suitable for administration by generic health professionals, as well as by specialists including clinical and neuropsychologists, medical practitioners, nurses, occupational therapists, physiotherapists, speech pathologists, and social workers. There is a vast array of such measures, and the observations made in 1969 by Lawton and Brody, whose instrumental activities of daily living scale continues to be widely used today, still apply: "The present state of the trade seems to be one in which each investigator or practitioner feels an inner compulsion to make his own scale and to cry that other existent scales cannot possibly fit his own setting" (p. 179). Indeed, recent years have seen an explosion of published tests, scales and questionnaires. More than one quarter of the instruments included in this compendium were published in the last 10 years.

Good assessment is fundamental to evidence-based clinical practice. The advantage of using standardized assessment instruments is that they provide a systematic and often objective means of evaluating level of functioning. This may be an end in itself, as in differential diagnosis, or it may provide a baseline against which future change (either improvement or deterioration) can be measured. Sometimes the need will be for prediction of the natural history and course of the condition; other times the baseline will be used to measure the effect of a therapeutic intervention. Prigatano and Pliskin (2003) and others observed that there is an increasing pressure to justify services – the best measures will yield the most valid results. Additionally, results from assessments can be used in clinical practice to describe levels of functioning from various perspectives, identify areas of need, ascertain the differential contribution of a range of factors, inform treatment planning and decisions, help people to make practical decisions, and educate families and people with ABI as well as other professionals.

As shown in the ICF model in the next section, a person's level of functioning can be assessed from a variety of perspectives (e.g., body system, functional activities, social role and participation, environmental milieu), and in turn, level of functioning is a consequence of interaction among such factors. The assessment instruments presented in this volume examine functioning from each of these various perspectives, and best practice suggests that comprehensive evaluation of an individual requires evaluation of each domain. Hall (1992) and Wade (2003) proffer a series of questions that clinicians and researchers can pose to

refine the process of selecting measures. Even so, they still can be placed in the situation of not knowing what measures are available. Moreover, Jette and Haley (2005) point to the tension between the need for comprehensive and clinically sensitive outcome instruments and the demands from the field for measures that are feasible in busy clinical settings. A resource manual such as the present one can provide guidance in these respects.

A number of other compendia of assessment instruments for clinical populations is available. Some cover a range of health conditions, not only neurological disorders (e.g., Bowling, 1997; Cole, Finch, Gowland, & Mayo, 1995; Cushman & Scherer, 1995; McDowell, 2006; Sederer & Dickey, 1996). These generally include generic as well as condition-specific instruments. It is recognized that both types of assessment measures have advantages and disadvantages. Yet, the large and increasing number of instruments developed specifically to measure neurological and neuropsychological function are testimony to the limitations and short-comings that clinicians and researchers have found in the application of generic instruments to people with neurological conditions (Kersten, Mullee, Smith, McLellan, & George, 1999).

Indeed, the sheer volume of assessment measures developed specifically for the investigation of ABI demands a dedicated compendium. Such resources are available for specialized neuropsychological tests (e.g., Lezak, Howieson, & Loring, 2004; Mitrushina, Boone, & D'Elia, 1999; Strauss, Sherman, & Spreen, 2006). Compendia of assessment instruments that are suitable for administration by generic health professionals are also available, some of which focus on specific areas such as cognitive screening (e.g., Shulman & Feinstein, 2006; Strub & Black, 2000) and others address a range of functional areas (e.g., Herndon, 1997; Wade, 1992). In the years since these latter books were published, however, a multitude of new measures has appeared in the literature.

An important development, also since the publications of Herndon (1997) and Wade (1992), has been the introduction of the ICF. This is "a globally agreed framework and classification to define the spectrum of problems in functioning" (Geyh et al., 2004a, p. 137), which is likely to exert an increasing influence on clinical and research practice. Üstün, Chatterji, and Kostanjsek (2004) liken the ICF to the Rosetta Stone, enabling linkage of data across health conditions and interventions. Systematic reviews, such as that of Geyh et al. (2004b) examining assessment instruments used in clinical trials of interventions for stroke, showed how concepts can be successfully linked to the ICF. Eighty-three different ICF categories were measured in at least 10% of trials, and more than 100 additional ICF categories for less frequently measured concepts. The present volume draws on the ICF framework to classify instruments for ABI.

Methodology

A range of methods was used to identify and select instruments for inclusion in this compendium. The literature was examined using various procedures. Searches of the electronic databases, Medline and PsycINFO, were used to identify scales in cognate areas of ICF domains and categories pertinent to ABI (e.g., delirium, memory questionnaires, community participation). Additionally, searches were conducted of websites, along with hand-searching of reference lists, review papers, books, journals, as well as recommendations from colleagues and the author's personal reference collection.

Candidate instruments were examined to identify those meeting the following five selection criteria for inclusion in the book:

1 An empirical study of the instrument, using an ABI population (or one at risk of ABI, e.g., older adults investigated for dementia), was published in a scientific, peer-reviewed journal.
2 Information was available on the psychometric properties of the instrument.
3 The instrument was suitable for administration by a generic health professional and was not restricted to a particular discipline (e.g., specialist neuropsychological tests).
4 Administration and/or scoring procedures did not require specialized equipment, although some commonly available and portable stimulus materials were deemed acceptable (e.g., pen and paper, stopwatch, torch, picture cards, common objects).
5 The instrument was in current clinical and/or research use and available in the English language.

For reasons of space, it was not possible to include all pertinent measures identified. The guiding principle for the final selection was to provide a representative array of instruments across broad ranges of functioning, at the expense of exhaustive coverage of a narrow area. For some areas (e.g., general cognitive screening, self-care functions) there are large numbers of scales, but the item content and structure of many instruments are very similar, thereby raising the question of the value of a detailed inclusion of all scales in these areas. Consequently, instruments selected for inclusion in this volume are those with adequate psychometric properties, as well as those representing industry standards, in frequent use, or having special features.

The principle of a broad coverage of functional areas extended to including special-purpose instruments that

are not necessarily in wide circulation (e.g., scales to assess minimally conscious states, establish mental competence), as well as those with special features (such as evaluation of neglected groups, e.g., people in advanced stages of dementia, patient/client-centred approaches). An effort was made to cover the spectrum of ABI, including progressive conditions (such as Alzheimer's disease and other dementias), as well as non-progressive conditions (such as stroke, traumatic brain injury). Appendix A lists the clinical conditions for which the included instruments were originally developed and with which they are currently used.

Inevitably, there are omissions. Sometimes these will be author-related, and in particular the scope of the book did not allow inclusion of scales examining psychological well-being. Many such scales, however, are instruments developed for other populations that have been applied to ABI groups, and the decision was taken to focus largely on those scales specifically developed for the ABI population rather than instruments that are available in other compendia. Another area not covered is that of so-called carer-burden. The reason for its omission relates to the conceptual framework of the ICF used as the structure for this book, which explicitly excludes the providers of support (i.e., caregivers) – see the introduction to Chapter 9 for discussion of this point. Furthermore, some neurological conditions (e.g., dementia, traumatic brain injury) contain a much larger number of published instruments than other conditions (e.g., neurotoxicity, cerebral neoplasms) and the scales featured in this book reflect this imbalance. In other situations, the apparent omissions reflect the state of the field – for instance, there is a dearth of instruments suitable for the assessment of children with ABI.

Structure of the entries on instruments

In order to facilitate use of this compendium, each entry describing an instrument is written as a stand-alone report and follows the same format. The structure of the entries has been informed by the characteristics delineated by Andresen (2000). A particularly appealing aspect of her set of 11 characteristics is the blend of clinical considerations (viz. administrative and respondent burdens, availability of alternative forms, cultural/language adaptations, normative/comparative data), along with the conceptual underpinnings of the instrument and the strength of its measurement properties (viz. conceptual characteristics, measurement model, instrument bias, reliability, validity, responsiveness). These characteristics and criteria, which appear in various configurations in many psychometric texts, provide the "gold standard" against which instruments can be evaluated and compared.

By the same token, it is also recognized that various psychometric or clinimetric criteria may differ in relevance according to the purpose of the instrument (Kirshner & Guyatt, 1985). Responsiveness, for example, is more important for instruments whose purpose is evaluative rather than diagnostic (Guyatt, Walter, & Norman, 1987); internal consistency may be compromised in those diagnostic or prognostic instruments that, perhaps in the interests of minimizing respondent burden, intentionally select a small set of items that make separate and distinctive contributions to the scale; knowledge of practice effects is particularly relevant for cognitive tests and they need to be taken into account in subsequent administrations of the instrument, and so forth.

The intention of the standardized presentation of each entry is to provide the reader with practical information, including item description, administration and scoring procedures. Wherever possible and feasible, items from instruments that are in the public domain are reproduced, using a standardized format to lend consistency of presentation of the scales across the book. In so doing, however, this compendium is not intended to be a replacement for the test manual, and users are advised to consult the original source. Information is also provided to assist the reader to determine the calibre of the scale in terms of the manner of its initial development and psychometric properties. The entries do not provide an exhaustive coverage of all the published psychometric studies on an instrument. Rather, the aim has been to strike a balance between detail and breadth of coverage, such that the reader gains an overall flavour of the characteristics of the instrument. Every effort was made to identify pertinent psychometric information, but some relevant references may have been missed. Each entry concludes with a brief commentary, regarding the strengths and limitations of the instrument. A selection of key references, with a psychometric focus, is also included.

Terminology and definitions

The screening tests, rating scales and questionnaires included in this compendium are largely based on behavioural observation, but they differ according to the way in which (a) information is collected and (b) responses are coded. Classification of the types of instruments is operationally defined as follows:

- *Objective tests or performance-based scales:* Those instruments that objectively measure observable performance. In most cases, the veracity of the response can be readily ascertained by an objective criterion (e.g., "repeat these numbers after me: 5, 8, 3"; "open your eyes"). Responses may be scored

using a variety of procedures. Sometimes a continuous score range is used, such as the number of words correctly recalled or the time taken to complete a task. For other tests, the clinician elicits a behavioural response that is then classified into a hierarchy according to predetermined criteria; for example, whether the eyes open spontaneously, after verbal request, in response to noxious stimuli, not at all. Other instruments in this category measure the presence or other objectively verifiable characteristic of natural observations.

- *Rating scales:* Those instruments where the response involves a judgement, generally using a rating scale describing intensity, frequency or other characteristic (e.g., "how much pain do you experience?", "how often do you forget things?", "how well do you get along with other people?"). Responses for many rating scales use a Likert-type rating scale, for example, a 5-point scale from "not at all" to "a lot". Ratings can be made by a clinician, using behavioural observation, clinical judgement or direct questioning. Ratings can also be made by an informant (such as a relative, friend, caregiver) or can be self-ratings by the person with/at risk of ABI.
- *Questionnaires/interviews:* Those instruments using open-ended questions in which the respondent is free to give an individualized response (e.g., "when did you have your injury?", "what duties did your work entail?", "what problems do you experience?").

A uniform set of terms is generally used throughout the book, and on occasion these may depart from terms that authors of an instrument have used. For instance, there is considerable variability in the way in which authors describe sources of information provided by proxies (e.g., relative, family member, significant other, caregiver, informant). In the present volume, the term "informant" is frequently used to refer to all proxy respondents who are not clinicians. Similarly, a report provided by the person with ABI (who may be a patient, client, resident, participant, or respondent, depending on the setting) is generally referred to as "self" report. Following on from Wade and Halligan (2003) the person with/at risk of ABI is also often referred to as a patient, this being "the most appropriate word for someone who is in contact with and using health care systems . . . The word *client* suggests a different relationship, not the type usually found in health professional relationships" (p. 350). An exception to this principle is terminology used by authors to refer to various cognitive constructs and processes. For example, in the area of memory authors use different labels to refer to very similar processes (e.g., short-term, recent, anterograde, episodic) and in these instances the terminology used by the authors to describe/classify items from their instruments is retained. Variation also occurs in definitions of measurement properties of instruments. For example, the internal consistency of an instrument is conceptualized by some authors as a component of reliability and by others as an aspect of validity. A standard set of definitions for common psychometric properties, consistent with those used by Hinderer and Hinderer (2005), has been adopted for this book (see Table 1.1), and these may vary from terms used by the authors. Additionally, Appendix B presents a list of abbreviations used in this compendium.

Diagnostic tests, a number of which are described in Chapters 2 to 6 in Part A, need to provide information on diagnostic accuracy. This can be done by using a criterion-referenced measure or normative data. The former compares the new test against accepted standards, procedures or criteria (such as a diagnosis). Commonly used statistics to judge diagnostic accuracy include likelihood ratios, defined as "the odds that a given level of a diagnostic test would be predicted in a patient with (as opposed to one without) the target disorder" (Sackett, Haynes, Guyatt, & Tugwell, 1991, p. 120) and sensitivity/specificity. Cut-off scores to indicate the presence/absence of the condition are established, often using receiver operating characteristic (ROC) curves, and investigators usually report on the levels of sensitivity, specificity and/or likelihood ratios obtained using the cut-off scores.

Generally, there is a trade-off between sensitivity and specificity, and different situations will dictate the desirability of one over another: screening tests often require high sensitivity to maximize detection of real cases, whereas other situations may demand high specificity to screen out non-cases (e.g., clinical situations depending on the base rate of the condition, clinical trials and other types of research studies). Different cut-off scores on a single test may be established to differentiate diagnostic conditions (e.g., dementia vs no dementia; Alzheimer's disease vs frontotemporal dementia). In the tables appearing for relevant entries, where practical the convention is used of referring to cut-off scores as follows: "x/y" where x and y refer to scores either side of the cut-off (e.g., present/absent, or vice versa according to the direction of the scores). This bypasses the misunderstanding that can arise when "score x" is stipulated as the cut-off (i.e., is score x, the cut-off itself, to be classified as present or absent?). Related concepts to sensitivity and specificity, which are reported less commonly but arguably are more clinically useful, are the positive and negative predictive values. These characteristics of diagnostic tests, described by Sackett, Straus, Richardson, Rosenberg, and Haynes (2000), among others, are easily calculated using Table 1.2.

Table 1.1 Psychometric properties frequently examined by scales included in this book

Term	*Definition*
Validity	The extent to which the test measures what it was designed to measure (i.e., *what* the test measures)
Types of validity:	
Content	The test provides a representative sampling of the domain of behaviours. Methods use evidence provided for development procedures of the test and use of expert judges
Criterion	Extent to which the test measures (is correlated with) a specific criterion
(a) Concurrent	The criterion is obtained at the same time as the test is administered
(b) Predictive	The criterion is obtained at some time after the test is administered
Construct	Extent to which the test measures a theoretical construct or trait. Methods use factor analysis, multitrait–multimethod matrix
Internal consistency	Homogeneity of items within a test, a statistical test of content sampling
Convergent and Divergent	The test is correlated with similar constructs, and the test is *not* correlated with dissimilar constructs
Discriminant	The test discriminates between groups with different characteristics pertinent to the test
Reliability	Reproducibility or consistency of scores obtained on the test (i.e., *how well* the test measures what it measures)
Types of reliability:	
Alternate form	An alternate (or parallel) form of the test with comparable item content, response format and scoring procedures. Important for instruments subject to practice effects (e.g., cognitive tests)
Inter-rater	Extent of agreement between scores of two (or more) independent examiners of a single test administration or behavioural observation
Test–retest	Also referred to as intra-rater reliability or temporal stability. Refers to the stability of test scores over time. The interval should be sufficiently long to counteract effects of memory of the previous administration, but short enough to ensure clinical change does not occur. Deyo, Diehr, and Patrick (1991) suggest a 1–2 week interval
Responsiveness	Sensitivity to detect true changes occurring in the individual, as opposed to random fluctuations (error) against which the test should be impervious (see test–retest reliability)

Table 1.2 Determining sensitivity, specificity, positive predictive value and negative predictive value of a test

		Target disorder		
		Positive	*Negative*	
Test result	Positive	a	b	a+b
	Negative	c	d	c+d
		a+c	b+d	

- Sensitivity: Proportion of people with the target disorder who have a positive test result (a/(a+c))
- Specificity: Proportion of people without the target disorder who have a negative test result (d/(b+d))
- Positive predictive value: Proportion of people with a positive test result who have the target disorder (a/(a+b))
- Negative predictive value: Proportion of people with a negative test result who are free of the target disorder (d/(c+d))

Studies published in the older literature often used Pearson (r) or Spearman (r_s) correlation coefficients to examine aspects of an instrument's reliability, or used percentage agreement in the case of dichotomous data. Current practice recommends the use of the more conservative intra-class correlation coefficient (ICC) for continuous data because it takes into account not only the rank order of the association between data points but also score differences. Similarly, the kappa statistic, which takes account of chance level of agreement, is recommended for dichotomous classifications; weighted kappa, used for ordinal data, adjusts for the magnitude of the disagreements. The criteria of Cicchetti (1994, 2001), presented in Table 1.3 are used to describe the clinical or practical significance of (i) the ICC and kappa statistic, (ii) Cronbach coefficient alpha, which is commonly used to determine the internal consistency of a test, and (iii) diagnostic accuracy for sensitivity, specificity, positive and negative predictive values. As noted earlier, however, the importance of coefficients for Cronbach alpha and the levels of sensitivity/specificity may vary according to the purpose of the instrument and its particular applications. If Pearson coefficients are used for reliability analyses, then high values are required and the range $r = .80$ to $r = .90$ is recommended (Anastasi & Urbina, 1997).

Table 1.3 Descriptive terms corresponding to coefficients for intra-class correlation (ICC), kappa, Cronbach coefficient alpha, sensitivity, specificity, positive and negative predictive values (after Cicchetti, 1994, 2001)

Level of clinical significance	*ICC and kappa*	*Cronbach coefficient alpha*	*Sensitivity, specificity, positive and negative predictive values*
	Coefficient	*Coefficient*	*Diagnostic accuracy (%)*
Excellent	≥.75	≥.90	90–100
Good	.6–.74	.8–.89	80–89
Fair	.4–.59	.7–.79	70–79
Poor	<.4	<.7	<70

In the assessment of inter-rater reliability, Andresen's (2000) criteria include patient-proxy reliability (i.e., the degree to which proxy or informant responses are similar to those of the respective patients). A number of instruments presented in this book have information available on patient-proxy reliability, but the coefficients are often relatively low, in the order of $r = .4$ to $r = .5$. Emphasis has not been placed on this type of reliability because when the patient is a person with ABI, the resulting coefficient may not so much measure the reliability of the instrument, but rather be confounded by compromised cognitive functioning, particularly if the patient experiences significant impairments in memory, insight and judgement. In this context it is more meaningful to report inter-rater reliability between different clinicians or different informants and, when available, such information has been provided.

When reporting coefficients for the individual instruments described in Chapters 2 to 10, results are generally recorded for the total score (where applicable and information is available), as well as the range for subscales/items (where applicable/available). Often the range of coefficients for the subscales/items is wide. The reader is assisted to make an overall determination of the number of subscales/items with good (e.g., ICC/$k \geq .6$) or poor (e.g., ICC/$k < .4$) coefficients by use of the following summary notation. A scale with 10 items, for example, may have the following profile entered into the "psychometric box" for test–retest reliability: "Total score $k = .7$, item range $k = .2$–$.9$ ($k \geq .6$ for 5/10 items; $k < .4$ for 2/10 items)", which means that kappa coefficients for 5 out of 10 items were .6 or higher, coefficients for 2 out of 10 items were less than .4, and thus, by implication, for the remaining 3 out of 10 items kappa coefficients were between .4 and .59.

Effect sizes are a common means of measuring the responsiveness of an instrument. The rule of thumb for interpreting the strength of the effect size varies according to the type of analysis, but for comparisons of mean scores Cohen (1988) suggested that $d = .8$ is large, $d = .5$ is medium, and $d = .2$ is small. These thresholds to classify effect sizes have not gone unchallenged, however, with some authors suggesting that lower values are significant for health status measures (Kazis, Anderson, & Meenan, 1989) and other authors arguing that higher values are required for treatment studies (Beeson & Robey, 2006). At the individual level, it is helpful to know whether or not the change that occurs (either improvement or deterioration) is beyond that which can be attributed to measurement error of the test (i.e., a statistically reliable change); and further, whether such a change is also clinically significant (i.e., that the patient's classification changes from dysfunctional to functional or vice versa). Few studies, however, report on these features. A number of procedures are available to calculate the reliable change index, and Perdices (2005) has provided a review of formulae.

All instruments presented in this book are quantitative and use numbers to summarize responses. A feature of scores yielded by many of these instruments is that the unit of measurement is at the ordinal level (see Cicchetti et al., 2006, for an interesting critical re-evaluation of levels of measurement). That is, there is a rank order or hierarchy of measurement units within an item (e.g., each item rated on a 5-point scale reflecting an increasing degree of disability). With ordinal data (unlike interval and ratio levels of measurement), it cannot be assumed that the intervals between the units are equivalent (e.g., that the degree of disability between response categories 2 and 3 is the same degree of disability as between response categories 3 and 4). Yet it is very common for developers of test instruments to transgress this assumption and sum scores from the items to form subscale scores, aggregate subscale scores to form a total score, and conduct statistical analysis on the data as if the units of measurement represent interval data. In other words, ordinal data are often treated in a manner that is appropriate only for interval and ratio levels of measurement. In a strict sense, "because the intervals on an ordinal scale are either not known or are unequal, mathematical manipulations such as addition, subtraction, multiplication, or division of ordinal numbers are not meaningful" (Domholdt, 2005, p. 246). Some authors of instruments acknowledge the licence they take in aggregating scores, and the consequent caution needed to interpret results. Increasingly, however, scaling procedures, such as Rasch analysis, are being applied to instruments to develop an equal-interval measure from raw scores (see Bond & Fox, 2007; Tesio, 2003). The routine application of such procedures in test development is a welcome advance in improving measuring instruments in the field of ABI.

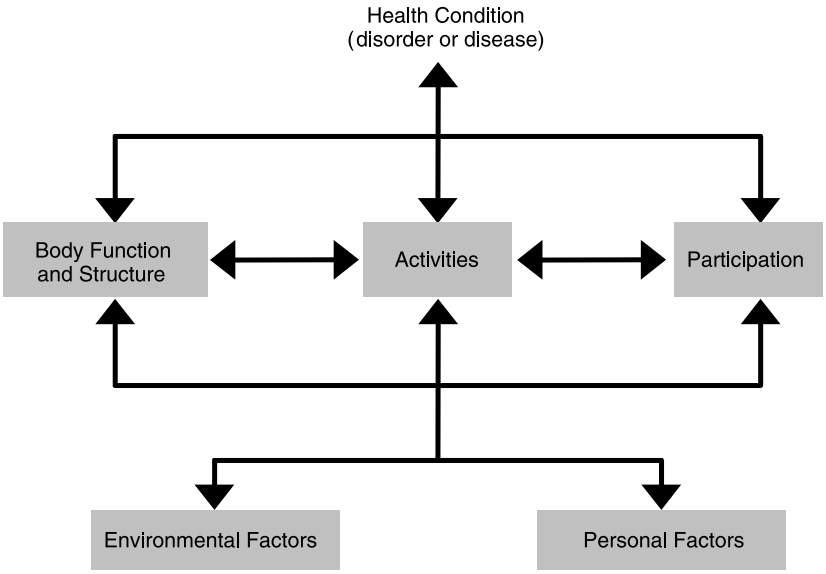

Figure 1.1 International classification of functioning, disability and health (reproduced from World Health Organization (2001). *International Classification of Functioning, Disability and Health* (Chapter 1, Section 5, Model of functioning and disability, p. 18, Fig. 1). Geneva: World Health Organization. Reprinted by permission of WHO Press).

The International Classification of Functioning, Disability and Health (ICF)

Organization of this compendium draws on the ICF taxonomy. The ICF is depicted graphically in Figure 1.1. A more specific tabular overview of the ICF is presented in Figure 1.2, which also shows correspondence between ICF domains and the chapters covered in this book. Appendix C (Tate & Perdices, 2008) provides a graphical representation of an "ICF tree" containing the categories and codes for selected Body Functions, Activities/Participation and Environmental Factors components nested within the above domains.

The aim of the ICF is "to provide a unified and standard language and framework for the description of health and health-related states" (WHO, 2001, p. 3). It is therefore in the interests of clinicians and researchers in the area of ABI, as well as in other fields, that the instruments they use to measure health and health-related states conform to such a standard. Stineman, Lollar, and Üstün (2005) report that the ICF has been accepted by 191 counties, and "is fast becoming the world standard for describing health and disabilities" (p. 1099). Challenges that were encountered in placing instruments developed for assessment of ABI within the ICF framework are discussed in the following section.

Origins and uses of the ICF

The ICF is a revision of the *International Classification of Impairments, Disabilities and Handicaps* (ICIDH; WHO, 1980). Development of the original ICIDH is described in detail in the 1980 publication and Bickenbach, Chatterji, Badley, and Üstün (1999) provide an informative review of issues necessitating the revision. The ICF retains a number of elements of the ICIDH, building on, updating and refining the terminology for impairments and disablement. It also differs from the ICIDH in significant ways; in particular, the inclusion of contextual factors and the use of neutral language (e.g., "participation" replaces "handicap") allow positive experiences to be described. In so doing, the ICF has more fully integrated medical and social models to adopt a "biopsychosocial" approach; in a rehabilitation context it "will engender expansion of the restorative rehabilitative paradigm to include empowerment" (Stineman et al., 2005, p. 1104).

The primary reference for the ICF (WHO, 2001) essentially comprises a listing of approximately 1500 alphanumeric codes describing various aspects of functioning. *The ICF Australian User Guide* (Australian Institute of Health and Welfare [AIHW], 2003) is intended to complement the ICF, and it provides information regarding the revision process, instructions in its use and its practical applications. Similar, but briefer overviews can be found in de Kleijn-de Vrankrijker (2003), Stucki, Cieza, and Melvin (2007), Stucki and Melvin (2007) and Üstün, Chatterji, Bickenbach, Kostanjsek, and Schneider (2003). Other descriptions of the ICF (e.g., Peterson, 2005) and critical reviews of its strengths and weaknesses (Wade and Halligan, 2003) have appeared, along with progress towards the development of a procedural manual to facilitate use of the ICF in health care settings in the USA (Reed et al., 2005). Discussions of the application of the ICF to clinical practice, education and research are also available

(Bruyère, van Looy, & Peterson, 2005; Stucki, 2007; Stucki & Grimby, 2007; Stucki, Reinhardt, & Grimby, 2007; Wade, 2005).

The WHO (2001) enumerates a range of potential applications of the ICF: for statistical purposes; as a research tool; for clinical practice in vocational and needs assessment, matching treatments with specific conditions, rehabilitation and outcome evaluation; in the planning and design of social policy; as a vehicle for education in curriculum design, raising awareness and taking social action. Ideally, it provides a scientific basis to learn about and research health and health-related states and provides a uniform coding system, thereby enabling comparison of data. It is recommended that for specialist services, such as rehabilitation, geriatrics and mental health, coding is conducted at the more detailed fourth-level category, whereas for surveys and health outcome evaluation coding at the second-level category is appropriate.

Components of the ICF

The ICF classifies health and health-related states; the health conditions (i.e., diseases, disorders, injuries, etc.) to which they relate are classified in the complementary WHO taxonomy, the *International Statistical Classification of Diseases and Related Health Problems*, 10th revision (ICD-10; WHO, 1992). The specific sections within components of the ICF are defined as follows (WHO, 2001, p. 10):

- *Body functions*: Physiological functions of body systems (including psychological functions).
- *Body structures*: Anatomical parts of the body, such as organs, limbs and their components.
- *Activity*: The execution of a task or action by an individual.
- *Participation*: Involvement in a life situation.
- *Environmental factors*: Physical, social and attitudinal environments in which people live and conduct their lives.

These sections (along with another, not yet classified, *Personal Factors*) work in an interactive and recursive fashion (see Figure 1.1), for example, Environmental Factors (e.g., distracting stimuli or ground texture) can interact with Body Functions (attention or balance respectively).

Structure of the ICF

A nested, hierarchical structure, described as stem–branch–leaf, is used in the ICF. It comprises parts, components, domains (also referred to as the first level of classification), blocks (which are "provided as a convenience to the user and, strictly speaking, are not part of the structure of the classification and normally will not be used for coding purposes"; WHO, 2001, p. 220) and categories (second, third and fourth levels of classification). This detailed organizational structure results in a very large number of categories. Therefore, a schematic summary of the ICF is depicted in Figure 1.2 adapted from Tate and Perdices (2008) to enable the reader to quickly grasp the overall structure of the ICF.

As shown in the figure, the ICF comprises two parts: (i) Functioning and Disability, and (ii) Contextual Factors. Within Functioning and Disability, there are two components: (a) Body (Functions and Structures) and (b) Activities and Participation. The component "Body" has eight domains for each of Functions and Structures, organized according to the body system (e.g., nervous system, cardiovascular system); each domain of Body Function corresponds to one of Body Structure. The component "Activities and Participation" contains a single set of nine domains, addressing both individual and social aspects of functioning (e.g., mobility, interpersonal interactions and relationships). Unlike the ICIDH, there is no recommended partitioning to distinguish domains *within* the Activities and Participation component. In fact, the ICF suggests any of four separate options for their differentiation, which "if users so wish [they can apply] in their own operational ways" (WHO, 2001, p. 16; see pp. 224–237 for options). This recommendation to use any one of a variety of methods of partitioning the Activities/Participation component is less than satisfactory in that it serves to create confusion among users and is not in keeping with the principle of promoting a unified framework.

Within the second part of the ICF, Contextual Factors, there are also two components: (a) Environmental Factors and (b) Personal Factors. The "Environmental Factors" component contains five domains, referring to physical, social and attitudinal environments. The second component, "Personal Factors", is not yet classified within the ICF "because of the large social and cultural variance associated with them" (WHO, 2001, p. 8). According to the ICF, Personal Factors comprise the following: "gender, race, age, other health conditions, fitness, lifestyle, habits, upbringing, coping styles, social background, education, profession, past and current experience (past life events and concurrent events), overall behaviour pattern and character style, individual psychological assets and other characteristics" (p. 17).

Some degree of variability occurs at the domain and category levels of the ICF. Domains may or may not have blocks (e.g., there are none in the Body Structures and Environmental Factors components), but all domains contain categories. Categories are subdivided. The domain of Mental functions, for instance, contains

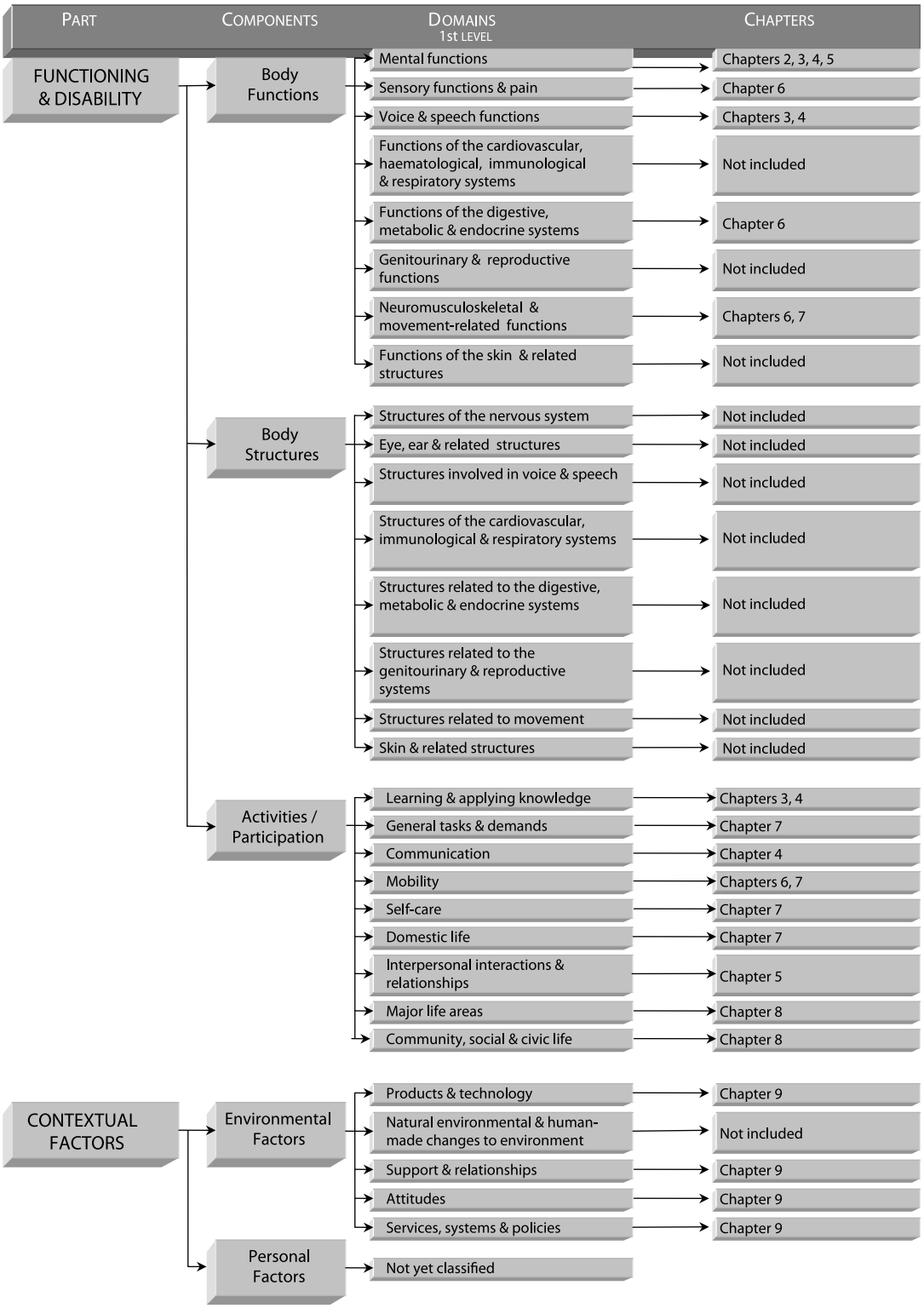

Figure 1.2 Overview of the International Classification of Functioning, Disability and Health, and chapters in which instruments mapping to ICF domains are located.

two blocks, one of which has 8 categories and the second block contains 14 categories. Each of these 22 categories is further subdivided. Figure 1.3 depicts the full ICF listing for the block, Global mental functions, which is subdivided to at least the third level (orientation to person is subdivided to the fourth level).

The ICF recognizes both positive and negative aspects of the components. For Body Functions, Body

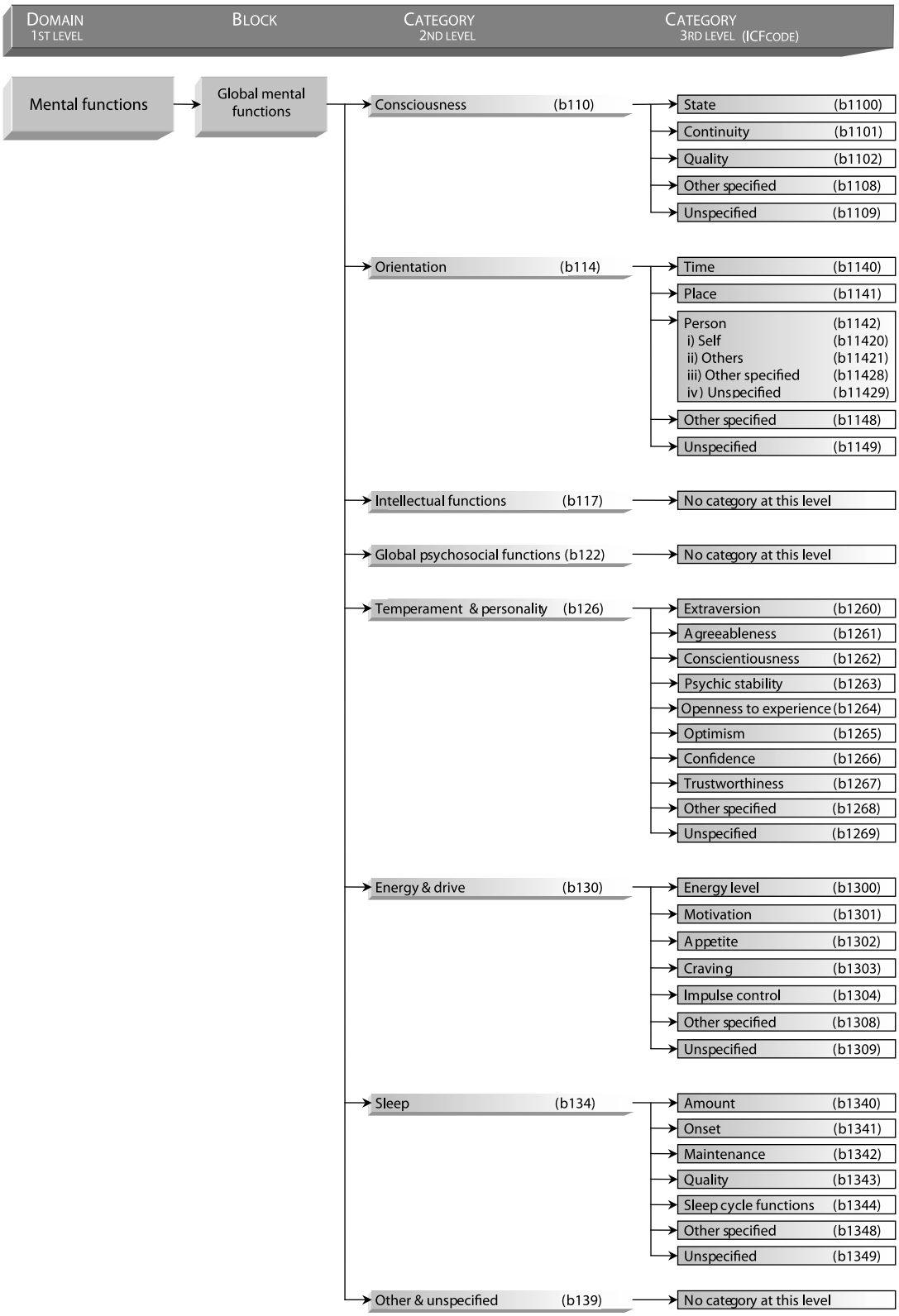

Figure 1.3 Full listing of the ICF block of Global mental functions.

Structures, Activities and Participation, the positive aspect is labelled *functioning*, as defined above. The negative aspects are labelled *impairments* for Body Functions and Body Structures, and *limitations* and *restrictions* for Activities and Participation respectively. The term *disability* is used as an umbrella term to refer to

impairment, activity limitation and participation restriction. For Environmental Factors, positive aspects are labelled *facilitators* and negative aspects *barriers* or *hindrances*.

Codes and qualifiers used in the ICF

As noted, each of the ICF categories is assigned a code, using alphanumeric notation: commencing with "b" for body functions, "s" for body structures, "d" for domain (referring to domains of the Activities and Participation component, which alternatively can be referred to as "a" and "p" respectively if the user so desires) and "e" for environment. For example, as shown in Figure 1.3, the code b1142 is classified to the fourth level and refers to "orientation to person", which lies within b114 second-level "orientation function", within the block of Global mental functions, within the domain of Mental functions (b110–b139), within the component of Body Functions. In total, there are 1424 codes at the third and fourth category level (WHO, 2001, p. 220). The category codes are fully enumerated in the 2001 WHO publication (see also Appendix C for codes attached to the Body Functions and Activities/Participation components that are addressed in this volume).

The ICF also advises the use of at least one qualifier, without which "the codes have no inherent meaning" (WHO, 2001, p. 222). The qualifiers are numeric descriptors that appear following a point after the code. The first qualifier is generic, referring to extent or severity; Body Structures additionally use second and third qualifiers to designate the nature of the impairment (e.g., partial absence) and location of impairment (e.g., left side) respectively. Two codes are used for Activity Limitation and Participation Restriction, which refer to the environments in which the measurements occur. The first code refers to *performance* (i.e., what a person actually does in the current or usual environment, including use of aids and personal assistance) and the second refers to *capacity* (i.e., the person's ability or highest level of functioning occurring in a standardized environment, such as a testing area, typically reflecting their "true ability which is not enhanced by an assistive device or personal assistance"; p. 230). Identifying the gap between performance and capacity "provides a useful guide as to what can be done to the environment of the individual to improve performance" (WHO, 2001, p. 15). Environmental Factors uses the same set of numeric qualifiers as impairments to describe the extent of the barriers with a – sign preceding the qualifier; facilitators use the same set of codes with a + sign preceding the qualifier.

The first qualifiers for impairments, the performance and capacity qualifiers for Activity Limitation/Participation Restriction, and environmental factors, all of which refer to the *extent* of the problem, are tabulated in Table 1.4; coding for other qualifiers is listed in Annex 2 of the ICF publication (WHO, 2001). Taking the above example of disorientation to person, a severe impairment would be coded b1142.3. Stineman et al. (2005) and Tate and Perdices (2008) provide worked examples of the application of the ICF and their codes in clinical practice.

Table 1.4 First qualifiers for ICF codes

Code	*Definition*	*Percentage*
.0 – no problems	none, absent, negligible . . .	0–4
.1 – mild problem	slight, low . . .	5–24
.2 – moderate problem	medium, fair . . .	25–49
.3 – severe problem	high extreme . . .	50–95
.4 – complete problem	total . . .	96–100
.8 – not specified		
.9 – not applicable		

Adapted from World Health Organization (2001). *International classification of functioning, disability and health*. Geneva: World Health Organization.

Further development of the ICF

It is recognized that the ICF is an evolving classification, and the 2001 reference publication points to further developmental work that is required. There is also discussion in the literature regarding the practical application of the ICF. For example, it has been tailored for specific purposes, one of these being the development of "core sets" of ICF categories pertinent to various health conditions (see special issues of the *Journal of Rehabilitation Medicine* (Supplement 44, 2004) and *Disability and Rehabilitation* (Issue 7/8, 2005)), the ICF checklist for use in clinical practice, and the availability of a procedural manual (AIHW, 2003). Further developmental work is being conducted on the use and reliability of the codes (see Cieza et al., 2002; Cieza, Geyh, Chatterji, Kostanjsek, Üstün, & Stucki, 2005; Granlund, Eriksson, & Ylvén, 2004; Okochi, Utsunomiya, & Takahashi, 2005), along with empirical studies on the factor structure of the Activities/Participation component (Jette, Haley, & Kooyoomjian, 2003). Development of the Personal Factors component is specifically identified as an area of future work, and this is particularly relevant for the area of ABI in terms of an apparent overlap with some of the categories from the Mental functions domain (see below).

Placing measuring instruments for ABI within the ICF taxonomy

Challenges

A number of challenges were encountered in attempting

to place instruments designed for assessing ABI into the ICF taxonomy. One insurmountable difficulty is that many instruments currently used in clinical and research practice were developed prior to the introduction of the ICF. Thus, the structure of such instruments reflects the clinical manifestation of impairments and/or disablement in people with ABI, rather than adhering in an a priori way to a taxonomic structure.

As a consequence, a large number of instruments included in this book, even those addressing a very specific area of functioning, such as motor function, contain an admixture of items crossing Body Functions and Activities/Participation components (e.g., domains of Neuromusculoskeletal and movement-related functions vs Mobility respectively). The crossing of ICF components as well as domains also occurs in the Global psychosocial functions category (Mental functions domain of the Body Functions component) versus the Interpersonal interactions and relationships domain (Activities/Participation component). A third relevant area where admixtures occur is the speech/language/communication area. Within the Body Functions component is the Voice and speech domain and the Language category (Mental functions domain). In turn, these can be contrasted with the Communication domain within the Activities/Participation component.

Reed et al. (2005) have also commented on overlapping ICF codes between ICF components. By way of example they contrast the Body Function, Expression of written language, with the Activity, Writing. They note that "these items cannot be distinguished clinically and would be assessed using the same tests or procedures. That is, expression of written language cannot be assessed except by writing" (p. 126). At a conceptual level, however, it is recognized that a distinction *can* be drawn between the linguistic and motor components of writing and, indeed, in clinical practice the impairment of one and/or the other can be readily distinguished. But a writing sample is needed for this purpose, and hence, in this instance, application of the appropriate code/s is difficult. Stineman et al. (2005) raise similar issues with respect to the Body Function "seeing" versus the Activity "watching"; and "hearing" versus "listening".

The complexities of accurate code assignment, along with the admixture of item content of ABI scales across various ICF components and domains, has implications for the way in which instruments are described and classified in the present volume. In other cases, the ICF does not cover particular constructs that are pertinent to health conditions. In their systematic review of outcome measures used in clinical trials of interventions for depressive disorders, Brockow et al. (2004) found that the ICF did not include a number of "personal concepts" contained in measures used by researchers (e.g., locus of control, life satisfaction, self-esteem).

Other challenges centred on the level of agreement between current conceptualizations of ABI versus the ICF constructs and terminology. For example, although Personal Factors are defined as the particular background of an individual's life and living, and "comprise features of the individual that *are not* part of a health condition or health states" (WHO, 2001, p. 17; emphasis added), in a number of neurological conditions some personal factors that represent cognitive/psychological constructs can, in fact, be "impaired" as a direct consequence of the health condition (e.g., executive functions regulating problem-focused or emotion-focused coping strategies in frontal systems dysfunction; the store of knowledge in semantic dementia). In the area of ABI, the Body Structure relevant to the health condition (viz. the brain) is itself responsible for these personal factors. Thus it is difficult to conceptualize the Personal Factors as merely contextual – rather, they are integral to Body Functions. A proposed method of distinguishing between the two is that if one of the constructs from the Personal Factors component is impaired (e.g., coping skills as a result of executive impairment with frontal systems dysfunction), then it should be classified and coded as an impairment (in this case, of Mental functions); not as a Personal Factor. In this sense, because Personal Factors are not part of functioning, they cannot be impaired, limited or restricted; age and race being clear examples of this principle (personal communication, A. Cieza, 18 May 2008).

Notwithstanding the laudable objective of the ICF to establish a *lingua franca*, important differences in terminology used in the ICF and current nomenclature in the area of ABI were encountered. This was particularly notable in the domain of Mental functions. For example, the term "executive functioning", appearing in the second edition of Lezak's (1983) seminal reference work, has been standard usage in the field of neuropsychology for decades, replacing the older term "higher cognitive functioning" that is currently used in the ICF. Similarly, neuropsychologists refer to "self-awareness" (see Prigatano & Schacter, 1991) rather than the ICF terminology, "experience of self". Where discrepancies occur, preference has been given to current ABI terminology.

Moreover, it can be appreciated from Figure 1.3 that a large number of specific areas of function are addressed at the category level of the ICF, and Appendix C provides the specific detail for five domains of the Body Functions component, nine domains of the Activities/Participation component and four domains of Environmental Factors that are addressed in this volume. Some scales included in this compendium focus on the degree of detail at the ICF category level. This was commonly

the case for scales of mental functions, where individual tests are available for virtually all of the second-level categories described (e.g., consciousness, orientation, attention, memory, etc.). By contrast, it is uncommon for scales addressing the Activities/Participation component to have this degree of specificity; rather scales of Activities/Participation generally adopt a broader selection of items, at the level of domain (first level); for example, self-care, domestic life (although there are some instances of specific scales addressing categories of the self-care domain, e.g., the Nottingham Stroke Dressing Assessment of Walker and Lincoln, 1990, 1991). Consequently, there is some variation in detail among scales in different chapters of this book.

Decisions

The foregoing considerations necessitated a slight reconfiguration of the ICF terminology and structure for this compendium in order to increase its relevance to ABI, particularly for the Mental functions domain. The decisions are summarized below and the rationale is provided in the relevant chapters. At the outset, it is recognized that overlap occurs between some Body Functions (as defined in the ICF) and Health Conditions (as defined in ICD-10). For example, delirium is classified within the ICF Mental functions domain (Consciousness category, b110), as well as within ICD-10 Chapter V: Mental, Behavioural Disorders (F05: delirium, not induced by alcohol and other psychoactive substances). Similarly, temperament and personality functions are classified within the ICF Body (Mental functions) domain (Temperament and personality category, b126), as well as within ICD-10 Chapter V: Mental, Behavioural Disorders (F07: personality and behavioural disorders due to brain disease, damage and dysfunction). A number of scales presented in this volume, particularly those examining Mental functions, have as their aim a diagnosis (e.g., delirium, fronto-temporal dementia). In this sense, they are arguably more properly considered assessments of the health condition per se (see ICD), as opposed to a consequence or component of that health condition. Nonetheless, because the categories that these instruments examine appear within the ICF nomenclature, they have been included in this compendium.

The guiding principle in organizing this volume was to place the ABI instruments in ICF domains that best represented the item content and made clinical sense – a model of best-fit, if you will. Consequently, in the interests of providing a simple and logical structure to this compendium, all instruments assessing a conceptually similar construct (e.g., speech/language/communication; movement-related/mobility function) are placed together. Additionally, some arbitrary decisions were made in reference to the grouping of sets of scales within the ICF structure. Thus, all scales in the speech/language/communication area appear within the Specific mental functions block (Mental functions domain) even though it could be argued that they are more properly placed within the Activities/Participation component (Communication domain). The reason that they have been grouped within the Body Functions component (Specific Mental Functions block) is because they assess a specific cognitive function (as do attention, memory, etc.). Figure 1.2 indicates the chapters that address those ICF domains represented by instruments included in this book.

More specifically, in Part A, Chapters 2 to 6 describe instruments assessing Mental functions, Sensory functions and pain, Voice and speech, Neuromusculoskeletal and movement-related functions, as well as the Ingestion category from the Digestive, metabolic and endocrine domain. Within the ICF taxonomy, these five domains fall within the component of Body Functions (see Figure 1.2). Although the Body Functions component comprises an additional three domains (Cardiovascular, haematological, immunological and respiratory; Genitourinary and reproductive; and Skin and related structures), these have less direct relevance to ABI. In keeping with common clinical practice in ABI, the instruments in Part A are grouped into two sections: (i) Mental functions (Chapters 2 to 5) and (ii) Sensory, ingestion and motor functions (Chapter 6). The imbalance in the number of chapters reflects the quantity of standardized instruments in the respective areas of functioning; the tradition of psychology (i.e., mental functions) being grounded in functional measurement. The specific chapters primarily addressing ICF domains and categories are described below.

Mental functions

The seven specific second-level categories of the block of Global mental functions are reconfigured for Chapters 2 to 5 in order to facilitate an integration of the ICF with current clinical conceptualizations of ABI. For reasons explained in the introduction to Chapter 2, the first two ICF categories of the Global mental functions block (Consciousness and Orientation) are combined. Intellectual functions is relabelled with the more commonly used term in ABI parlance, Cognitive, and entitled General cognitive functions (Chapter 3) to distinguish it from Specific cognitive functions (Chapter 4). Scales in Chapter 3 often include items that are pertinent to other categories of Mental functions. As explained in the introduction to Chapter 5, Global psychosocial functions, Temperament and personality functions and Energy and drive functions (as well as three categories from Specific mental functions and the Interpersonal

interactions and relationships domain from Activities/Participation) are combined. Scales of Sleep functions, the final category of Global mental functions, are not considered in this volume.

The second block, Specific mental functions, contains 11 specific second-level categories (see Appendix C) and a number of representative tests are described in Chapter 4, Specific cognitive functions. Instruments included in Chapter 4 address the following ICF categories: (i) Attention, (ii) Memory, (iii) Higher-level cognitive (relabelled with the more commonly used term, Executive), (iv) Language (including the Voice and speech domain from Body Functions, as well as the Communication domain from Activities/Participation), and (v) Experience of self and time (relabelled with the more commonly used term, Self-awareness). At the item level, scales in Chapter 4 (and Chapter 3) overlap with the Learning and applying knowledge domain from Activities/Participation. Instruments assessing (vi) Emotional functions and (vii) Thought functions, are covered in Chapter 5 on scales assessing the Regulation of behaviour, thought and emotion. Specific instruments assessing (viii) Psychomotor, (ix) Perceptual, (x) Calculation, and (xi) Sequencing complex movements are not covered. Items reflecting some these Specific mental functions categories are occasionally included in multidimensional scales (see Chapter 10).

Sensory, ingestion and motor functions

Tests and scales described in Chapter 6 map to at least three ICF domains from the Body Functions component: mainly (i) Sensory and pain, (ii) Functions of the digestive, metabolic and endocrine systems, and (iii) Neuromusculoskeletal and movement-related functions, as well as the Mobility domain from the Activities/Participation component. A number of performance-based measures that are suitable for use by generic health professionals are available. These have the advantage of providing a standardized and objective evaluation. Additionally, rating scales and self-report measures of sensory-motor functions also contribute to evaluation, and for some Body Functions are arguably the best methods of assessment, the obvious example being pain. As noted earlier in this chapter, there is often an admixture of motor function items between Body Functions and Activities/Participation components. All tests and scales that exclusively assess motor function, as distinct from multiple Activities/Participation domains including Mobility, are included in Chapter 6.

In Part B, Chapters 7 and 8 present scales relating to Activities and Participation. Within the ICF taxonomy, the Activities and Participation component contains nine domains (see Figure 1.2). Scales from three of the nine domains (General tasks and demands, Self-care, and Domestic life) are presented in Chapter 7 (Activities of daily living). As noted in the preceding paragraph, scales exclusively addressing the Mobility domain are presented in Part A, Chapter 6 (Sensory, ingestion and motor scales). It is not uncommon, however, for scales of basic activities of daily living to focus on self-care *and* mobility, and in these cases, where self-care items predominate, the scale is more appropriately placed in Chapter 7 rather than Chapter 6. A further two Activities/Participation domains (Major life areas and Community, social and civic life) are addressed in Chapter 8 (Participation and social role). The arbitrary demarcation of scales in Chapters 7 and 8 is acknowledged and the problem of admixtures of items across multiple domains in the Activities/Participation component means that there is not always a neat separation between the item content of scales located in Chapters 7 and 8. Multidimensional scales, which often include items at the Activities/Participation level, as well as the Body Function level, are presented in Chapter 10. Finally, instruments sampling the remaining three Activities/Participation domains (Learning and applying knowledge, Communication, and Interpersonal interactions and relationships) are dealt with in Chapters 3 to 5 in Part A, in the interests of locating conceptually similar scales together.

As noted, with few exceptions, scales for ABI classified in the Activities/Participation component do not address specific ICF categories in isolation. Rather, the approach is more global, and ABI scales of Activities/Participation tend to be spread across the nine domains. In order to enable the reader to quickly grasp the sampling of ICF domains within each instrument and compare the content of instruments, Appendix D provides a comparative checklist for the scales featuring in Chapters 7, 8 and 10, identifying the number of items in each scale that address the ICF domains within the Activities/Participation component. Additionally, Appendix E provides a comparative checklist of the item content of scales assessing functional activities of daily living from a clinical perspective.

Part C examines the single component of Contextual Factors currently classified in the ICF, Environmental Factors (Chapter 9). The importance of incorporating contextual factors into the ICF cannot be overstated. Its presence serves to remind clinicians and researchers that people with ABI (or other health conditions) are not defined by that health condition, but rather live in a physical, social and attitudinal environment that can exert a dramatic (positive or negative) influence on their functioning. The five domains comprising the component of Environmental Factors represent a diverse range. In some domains, notably Support and relationships, a number of instruments are available, but few

have been developed for or used with the ABI group. In other domains pertinent to the physical environment, specific scales are just starting to appear in the literature.

Part D (Chapter 10) is the final chapter of the compendium, containing scales that cannot be classified neatly within specific components of the ICF. They are described as multidimensional scales because they provide a sampling of disparate items from both the Body Functions and Activities/Participation components and their domains. A small selection of generic scales assessing so-called health-related quality of life is also included in Chapter 10.

Cautionary statements

It is recognized that for each of the components and domains of the ICF there are specialists who are trained to provide detailed and comprehensive evaluations of respective functions and their disorders: for example, clinical and neuropsychologists in Mental functions; physicians in Sensory and other body systems; speech pathologists in Voice and speech, Language, and Communication; physiotherapists in Neuromusculoskeletal and movement-related functions; occupational therapists, social workers and other allied health professionals in various domains of Activities and Participation and Environmental Factors. In particular, the tests of Mental functions described in this volume are essentially cognitive screening tests, and while these serve a useful purpose in many situations, they are not a substitute for a detailed neuropsychological or language assessment by a specialist clinician. Johnston, Keith, and Hinderer (1992, p. S13) recommend that:

> screening tests should be used cautiously for diagnostic, placement, or treatment planning . . . Screening tests are most effectively used to indicate the need for more extensive testing and treatment of specific problem areas. Flexibility and professional judgment are essential to the use of measures in professional practice.

Thus, while the instruments contained in this volume are recommended as suitable for administration by generic health professionals, it is expected that the administrator will adhere to standards of test administration and best clinical practice, as recommended by professional colleges and organizations (see Johnston et al. for discussion of measurement standards and responsibilities that are applicable to both test developers and test users).

An obvious caveat applies to the administration of rating scales, questionnaires and interviews. Responses on these instruments involve the person's perceptions. In situations where an actual, objective evaluation is desired, the veracity of responses on rating scales from people with ABI may be compromised when significant cognitive impairments, particularly in memory, judgement and/or awareness, are present. A score may well be produced, but the validity of that score needs to be evaluated. Even visual analogue rating scales (both vertical and horizontal) have been shown to be an unreliable method of measurement of some functions for people with stroke (Price, Curless, & Rodgers, 1999). For these reasons, rating scales are often completed by a proxy-respondent, generally a family member who has close contact with the person and knew them well prior to the onset of their ABI. Yet, this method, wherein the informant's responses are used as a "gold standard", can introduce another set of problems, because informants may over-estimate or under-estimate level of functioning for a variety of reasons (Kertesz, Nadkarni, Davidson, & Thomas, 2000; McKinlay & Brooks, 1984; Prigatano, Altman, & O'Brien, 1990). A number of the scales presented in this volume have data collected from three sources: patient, family member and clinician, and there are advantages and disadvantages to each. Who should do the rating? Wilson, Alderman, Burgess, Emslie, and Evans (1996) intimate that judicious selection of the family member is probably the best source, whereas Bennett, Ong, and Ponsford (2005) conclude that the treating clinician provides the most accurate evaluation.

On a final note, tests and scales are developed for different purposes, and that which is suitable for one application will be unsuited to another purpose. Hall, Bushnik, Lakisic-Kazazic, Wright, and Cantagallo (2001, p. 368) observed that "using a measure at the wrong phase of recovery may . . . jeopardize the validity of an otherwise valid scale". Accordingly, the selection of instruments featured in this volume is intended to present the reader with a representation of a variety of methods, procedures and formats, while at the same time enabling a reliable and valid evaluation of functioning. Responsibility for the selection and use of a particular instrument as suitable for a given purpose, however, rests with the clinician or researcher.

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Part A

Body Functions

Part A of this compendium contains five chapters that focus on the domains of most relevance to acquired brain impairment (ABI) within the Body Functions component of the World Health Organization (WHO, 2001) *International Classification of Functioning, Disability and Health* (ICF; see Figure 2.1 below and Appendix C): consciousness and orientation (Chapter 2); general cognitive functions (Chapter 3); specific cognitive functions (Chapter 4); regulation of behaviour, thought and emotion (Chapter 5); and sensory, ingestion and motor functions (Chapter 6).

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2 Scales of consciousness and orientation

Instruments presented in Chapter 2 map to the component, domain and categories of the *International Classification of Functioning, Disability and Health* (ICF; WHO, 2001) as depicted in Figure 2.1.

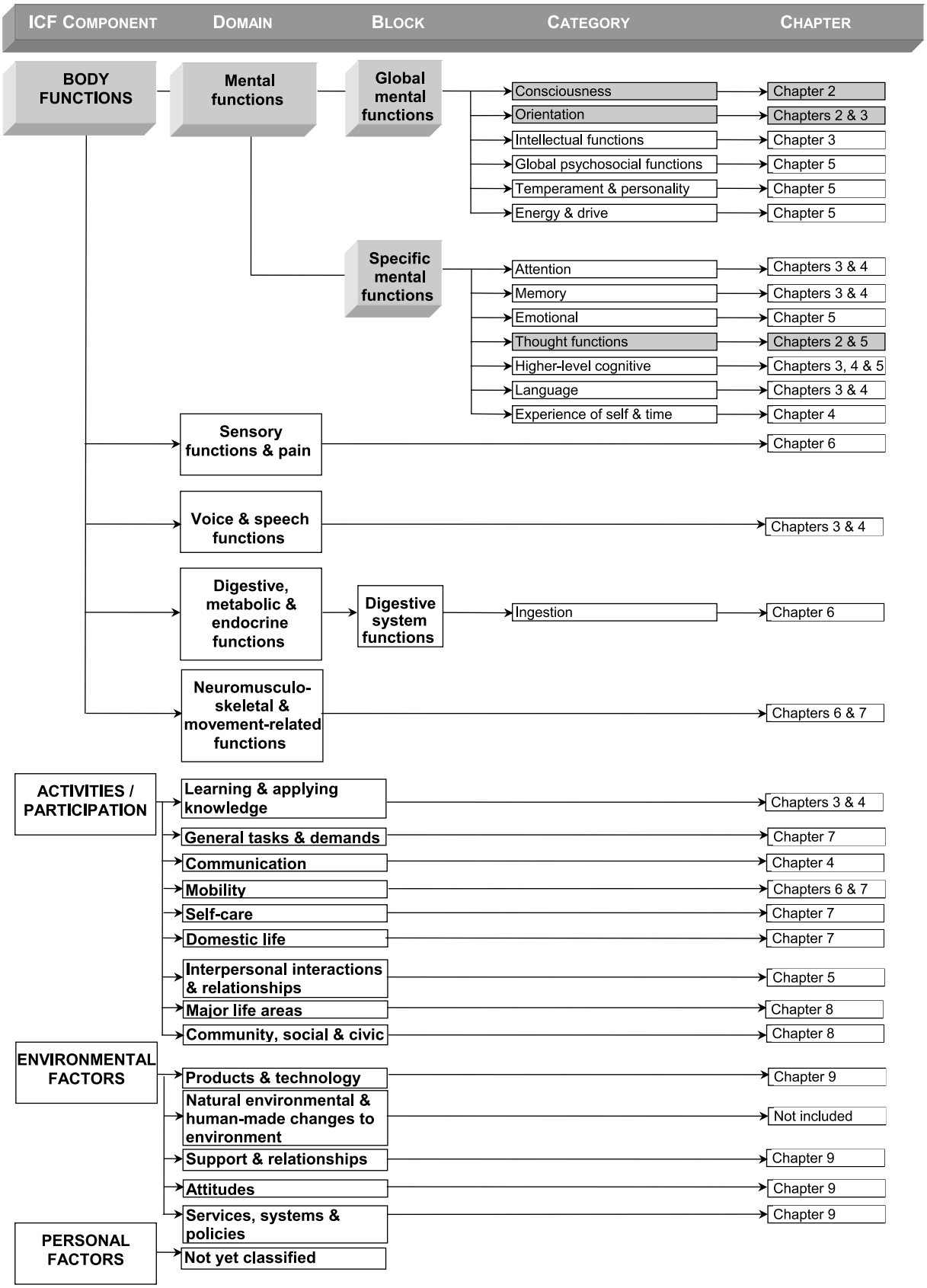

Figure 2.1 Instruments included in the compendium in relation to the ICF taxonomy – the highlighted component, domain and categories appear in this chapter. *Note:* The Figure presents a partial listing of five out of the eight Body Function domains and does not include any of the Body Structure domains. Categories for Mental functions also represent a partial listing and categories for the remaining domains are not listed. Refer to Appendix C for further detail on the ICF taxonomy.

Introduction

The ICF taxonomy draws a distinction between consciousness and orientation, which are the first two categories appearing within the block of Global mental functions (see Figure 2.1 and Appendix C). Within the ABI context, the constructs of consciousness and orientation represent altered states of consciousness, in contrast to other categories within Global mental functions. In recognition of this distinction, the present chapter groups together 17 scales, along with a number of their derivatives, measuring altered states of consciousness and orientation (some multidimensional scales, described in Chapter 10, also include items pertinent to this chapter). Within this grouping, natural divisions occur, and these form the structure of Chapter 2: coma and minimally consciousness states, delirium, and post-traumatic amnesia.

Section 1: Scales measuring coma, vegetative and minimally conscious states

Publication of the Glasgow Coma Scale (GCS; Teasdale & Jennett, 1974) heralded a standardized approach to measuring coma based on the quantification of systematic observations of behavioural responses. Along with this, in the decades since the GCS was published improved medical technology has enabled the survival of people who would have otherwise died (see Coleman, 2005). Some of these survivors can remain for many months in the vegetative state (VS) and minimally conscious state (MCS) with extremely impaired levels of awareness and responsiveness. An increasing number of scales has been developed to detect fine gradations of change in these patients, and a selection of these is described. Consensus-based diagnostic criteria to differentiate coma, VS and MCS (Giacino et al., 2002; Multi-Society Task Force on PVS, 1994; Teasdale & Jennett, 1974; further refined in Giacino, Kalmar & Whyte, 2004) are summarized in Table 2.1.

Table 2.1 Behavioural features distinguishing coma, the vegetative state and the minimally conscious state

Presence of coma	Requires absence of: i. eye opening ii. verbalization or mouthing words iii. response to commands iv. intentional movement
Emergence from coma	Requires presence of: i. periods of eye opening ii. return of autonomic functions, e.g., sleep–wake cycles, roving eye movements (without tracking ability)
Emergence from the vegetative state	Requires the presence of: i. reproducible movement to command ii. visual fixation iii. motor localization to noxious stimuli iv. intelligible verbalization *and* v. intentional (even if non-functional) communication
Emergence from the minimally conscious state	Requires the presence of all of the above, as well as: i. functional object use *and/or* ii. accurate, functional communication

Table 2.2 DSM-IV criteria for diagnosis of delirium

A	A disturbance of consciousness (i.e., reduced clarity of awareness of the environment) with reduced ability to focus, sustain, or shift attention
B	A change of cognition (such as memory deficit) or the development of a perceptual disturbance that is not better accounted for by a pre-existing, established, and evolving dementia
C	Develops over a short period (usually hours to days) and tends to fluctuate during the course of the day
D	Evidence from the history, physical examination or laboratory findings that the disturbance is caused by direct physiological consequences of a general medical condition.

Acknowledgement: *Diagnostic and Statistical Manual of Mental Disorders*, 4th ed. (1994), reproduced by permission of the American Psychiatric Association.

Section 2: Scales measuring delirium

The ICF classifies delirium within the category of consciousness; specifically, quality of consciousness. Some of the symptomatology characteristic of delirium also involves disturbance of thought function. Established criteria to diagnose delirium (*Diagnostic and Statistical Manual of Mental Disorders*, 4th ed., DSM-IV; American Psychiatric Association, 1994) are tabulated in summary form in Table 2.2.

Most delirium scales have been developed for people with a variety of medical conditions, often the older population. Many scales assessing delirium were identified in literature review. A number of these were considered to provide a valid evaluation of delirium, but were similar in item content to more widely used scales and hence were omitted in favour of the more established instruments. The five delirium scales selected for inclusion are those with sound psychometric properties, in current use in clinical/research settings, and considered to be industry standards or to have special features.

Section 3: Scales measuring orientation and post-traumatic amnesia (PTA)

At the upper level of altered states of consciousness are disturbances of orientation. Following emergence from coma after traumatic brain injury, a period of PTA usually occurs in which disorientation is a central (but not the sole) feature. PTA is defined as "an interval during which the patient is confused, amnesic for ongoing events and likely to evidence behavioral disturbance" (Levin, O'Donnell, & Grossman, 1979, p. 675). The importance of the duration of PTA is that it is a commonly used index of the severity of the initial injury and is one of the best predictors of recovery and outcome. Injury severity classifications using duration of PTA were described by Russell and Smith (1961) and later expanded by Jennett and Teasdale (1981), as summarized in Table 2.3.

Table 2.3 Traditional classifications of injury severity

Duration of PTA	*Traditional PTA severity classification (Jennett & Teasdale, 1981; Russell & Smith, 1961)*
< 5 mins	very mild
5–60 mins	mild
1–24 hours	moderate
1–7 days	severe
1–4 weeks	very severe
> 1 month	extremely severe

The WHO Collaborating Centre Task Force on Mild Traumatic Brain Injury (Carroll, Cassidy, Holm, Kraus, & Coronado, 2004) has revised the definition of mild injury to include all PTA durations up to 24 hours (thereby subsuming the category of moderate injury). The above groupings refer to PTA durations in isolation from other variables, and additional criteria that Carroll et al. use to define mild traumatic brain injury include GCS scores from 13 to 15 taken 30 minutes after injury, or loss of consciousness for 30 minutes, and/or other transient neurological abnormalities. Presence of skull fracture, intracranial lesions requiring neurosurgery, or persisting focal neurological deficits indicate more severe injury. Using GCS scores to classify injury severity, by convention, GCS scores from 3 to 8 indicate a severe injury, from 9 to 12 correspond to a moderate injury, and as noted above scores from 13 to 15 denote a mild injury. Von Holst and Cassidy (2004) observe, however, that in individual cases the GCS and PTA criteria may not be compatible (e.g., GCS score indicating mild injury and PTA score indicating severe injury). The rule of thumb takes the more severe classification for grading purposes. A range of methods and instruments are available to measure depth and duration of PTA, and five measures featuring prominently in the literature are described in this chapter. Orientation items feature in each of these scales, and additionally are often found as components of general cognitive screening tests, reviewed in Chapter 3.

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SECTION 1
Scales measuring coma, vegetative and minimally conscious states

Coma/Near Coma (C/NC) Scale

Rappaport, Dougherty, and Kelting (1992)

Source

The recording form for the C/NC is provided in Rappaport et al. (1992) and materials are also available on the website of the Center for Outcome Measurement in Brain Injury (http://www.tbims.org/combi/cnc/index.html). The recording form and a description of the C/NC levels appear below.

Purpose

The C/NC is an objective, clinician-administered test providing quantification of level of consciousness for patients with ABI in vegetative and minimally conscious states. It was developed so that "early microchanges in clinical status, which may be predictive of further progress, are not overlooked" (Rappaport et al., 1992, p. 628). The authors regard the C/NC as an expansion of the lower levels of the Disability Rating Scale (DRS; Rappaport, Hall, Hopkins, Belleza, & Cope, 1982; described in Chapter 10), and appropriate for those patients scoring ≥ 21 on the DRS (i.e., vegetative state). Rappaport (2005) also describes the clinical utility of the C/NC as providing a systematic method of charting changes in the patient, and a rationale for selecting and supporting long-term rehabilitation.

Item description

The 11 items of the C/NC examine response to simple commands and sensory stimulation, and document the presence of primitive reflexes. Specifically, the items comprise: auditory response (1 item), response to command (1 item), visual response (2 items), threat (1 item), olfactory (1 item), tactile response (2 items), pain (2 items) and vocalization (1 item).

Scale development

Limited information is available on the development of the C/NC, but Rappaport et al. (1992) describe it being revised a number of times following pilot testing. Scores from the C/NC are classified into one of five levels, but no information is provided on the procedures used to establish these levels.

Administration procedures, response format and scoring

Stimulus materials (bell, torch and ammonia sample) are required for administration. The C/NC is described as providing an easy and quick assessment, and the authors reported that administration was learned easily. Training on 5 to 10 patients is recommended for new raters and even after training, two independent clinicians should be used to ensure reliability. The authors suggest that for patients scoring ≥ 21 on the DRS, the C/NC is administered twice per day for 3 days, then weekly for 3 weeks, then every 2 weeks thereafter while DRS scores continue to be 21 or higher. If DRS scores fall below 21, the C/NC can be administered monthly, in combination with the DRS.

Responses to all items are rated on a 3-point scale: 0 (equivalent of maximal response), 2 (partial response), 4 (no response). A total score is obtained by summing scores for the 11 items, and dividing the score by the total number of items to obtain the average C/NC score. Average scores are then converted to levels: 0 (no coma), 1 (near coma), 2 (moderate coma), 3 (marked coma), 4 (extreme coma) using the descriptive categories of the scale (see below).

Psychometric properties

Information on the measurement properties of the C/NC is available from a number of sources. In the initial study, Rappaport et al. (1992) recruited 20 inpatients (age $M = 33.7$ years, range 12–70) from an inpatient rehabilitation unit in California, USA. Cause of injury was mainly road traffic crash and the initial C/NC administration occurred 8.9 months post-trauma ($SD = 10.59$, range 1–48). Patients were followed for 16 weeks. Two trained raters observed the patient simultaneously and made ratings independently. A consensus

score was used to validate the C/NC against the DRS and evoked potential responses (EPR). Information on temporal stability is available from Pilon and Sullivan (1996) who studied 12 patients (age $M = 50$ years, $SD = 15.26$; 2–27 years post-trauma) from a skilled nursing care facility in Montreal, Canada. Data on responsiveness are also available from a case series reported by Talbot and Whitaker (1994) in the course of their intervention study on sensory stimulation. The seven participants had been in an "altered state of consciousness" for more than 1 month. No statistical analyses were conducted on the data, but the individual scores were presented in the report for each subject, and analysis was conducted on these by the author to determine responsiveness. Psychometric properties of the C/NC, taken from Rappaport et al. (1992) unless otherwise stated, are shown in Box 2.1.

Box 2.1

Validity:	Criterion:
	Concurrent: with DRS: $r_s = .69$
	– with EPR: $r_s = .52$
	Construct: *Internal consistency:* Cronbach alpha: .43, .65, .65 for scores at 1, 8 and 16 weeks respectively after initial testing
Reliability:	Inter-rater: $r = .97–.98$
	Test–retest: Pilon & Sullivan: 2 weeks: ICC = .89
Responsiveness:	Initial C/NC score $M = 2.35$ ($SD = 0.60$) vs 16 weeks later $M = 1.52$ ($SD = 1.28$); $d = 1.38$
	Talbot & Whitaker: Significant improvement in scores before ($M = 2.72$, $SD = 0.55$) vs after ($M = 1.01$, $SD = 1.01$) a sensory stimulation programme; $z = –2.37$, $p < .02$, $d = 3.11$

Comment

A number of scales developed for people with severely altered states of consciousness provide a detailed, and thence necessarily time-consuming, evaluation of level of functioning. An advantage of the C/NC is its brevity (O'Dell, Jasin, Lyons, Stivers, & Meszaros, 1996), although this, together with item diversity, may be at the expense of internal consistency. Only a small research literature is available on the C/NC, but it has demonstrated very good inter-rater reliability, is stable yet responsive to changes in the patient when these occur, and shows evidence of concurrent validity. A drawback of the instrument is that the nomenclature of the C/NC does not correspond to more recent diagnostic criteria for vegetative and minimally conscious states as recommended by expert groups (e.g., Giacino et al., 2002).

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Coma/Near Coma Scale – Recording Form

Rappaport, Dougherty, and Kelting (1992)

Name: **Administered by:** **Date:**

Instructions: For patients with a Disability Rating (DR) score ≥ 21, i.e., vegetative state or greater. Complete twice a day for 3 days, then weekly for 3 weeks; every 2 weeks thereafter if DR score ≥ 21. If DR < 21 follow monthly with DR scores.

Whether or not patient appears receptive to speech, speak encouragingly and supportively for about 30 seconds to help establish awareness that another person is present and advise patient you will be asking him/her to make a simple response. Then request the patient try to make the same response with brief priming before 2nd, 3rd and subsequent trials. Make sure patient is not sleeping.

Parameter	Stimulus	No. of trials	Response measures	Score	Criteria	Date: / Time: / Assessor:
AUDITORY*	1. Bell ringing 5 s at 10 s intervals	3^	Eye opening or orientation towards sound	0 2 4	≥ 3 times 1 or 2 times No response	
COMMAND RESPONSIVITY with priming	2. Request patient to open or close eyes, mouth, move finger, hand or leg	3	Response to command	0 2 4	Responds to command 2 or 3 times Tentative or inconsistent 1 time No response	
VISUAL^^ with priming Must be able to open eyes; if not score 4 for each stimulus situation (items 3, 4, 5) and check here ☐	3. Light flashes (1/s × 5) in front; slightly left, right and up and down each trial	5	Fixation or avoidance	0 2 4	Sustained fixation or avoidance 3 times Partial fixation 1 or 2 times None	
	4. Tell patient "Look at me" move face 20 inches away from side to side	5	Fixation and tracking	0 2 4	Sustained tracking (at least 3 times) Partial tracking 1 or 2 times No tracking	
THREAT	5. Quickly move hand forward to within 1–3 inches of eyes	3	Eye blink	0 2 4	3 blinks 1 or 2 blinks No blinks	
OLFACTORY (block tracheostomy 3–5 seconds if present)	6. Ammonia capsule/ bottle 1 inch under nose for about 2 seconds	3	Withdrawal or other response linked to stimulus	0 2 4	Responds 2 or 3 times quickly (≤3 s) Slow partial withdrawal; grimacing 1 time No withdrawal or grimacing	
TACTILE	7. Shoulder tap – Tap shoulder briskly 3 times without speaking to patient: each side	3^	Head or eye orientation or shoulder movement to tap	0 2 4	Orients toward tap 2 or 3 times Partially orients 1 time No orienting or response	
	8. Nasal swab (each nostril: entrance only – do not penetrate deeply)	3^	Withdrawal or eye blink or mouth twitch	0 2 4	Clear, quick (within 2 s) 2 or 3 times Delayed or partial response 1 time No response	
PAIN (Allow up to 10 s for response) If spinal cord injury check here ☐ and go to stimulus 10	9. Firm pinch finger tip: pressure of wood of pencil across nail; each side	3^	See score criteria	0 2 4	Withdrawal 2 or 3 times General agitation/non specific movement 1 time No response	
	10. Robust ear pinch/pull × 3; each side	3^	Withdrawal or other response linked to stimulus	0 2 4	Responds 2 or 3 times General agitation/non-specific movement 1 time No response	
VOCALIZATION ^^ (Assuming no tracheostomy) If tracheostomy present do not score but check here ☐	11. None (score best response)	_	See score criteria	0 2 4	Spontaneous words Non-verbal vocalization (moan, groan) No sounds	

COMMENTS: (Include important changes in physical condition such as infection, pneumonia, hydrocephalus, seizures, further trauma, etc.)

Total C/NC Score (add scores): A	
Number of items scored: B	
Average C/NC score (A/B): C	
Coma/Near Coma Level (0–4): D	

* If possible use brain stem auditory evoked response (BAER) test at 80 db nHL to establish ability to hear in at least one ear.

^ Each side up to 3 times if needed.

^^ Consult with nursing staff on arousability; do not judge solely on performance during testing. If patient is sleeping, repeat the assessment later.

Levels of the Coma/Near Coma Scale

Rappaport, Dougherty, and Kelting (1992)

Level	Score	Description
0	**0.00–0.89 No coma**	Patients are consistently and readily responsive to at least three (of 10) sensory stimulation tests and show consistent responsivity to simple commands. This category overlaps and phases into the lower levels of the extremely severe disability category of the DRS (DRS scores 17 to 19).
1	**0.90–2.00 Near coma**	Patients are consistently responsive to stimulation presented to two (of 10) sensory modalities, or they are inconsistently or partially responsive to simple commands. This category overlaps and phases into the upper levels of the extremely severe disabled and lower levels of the vegetative state categories of the DRS (DRS scores 20 to 21 and 22 to 23, respectively).
2	**2.01–2.89 Moderate coma**	Patients are inconsistently responsive to stimulation presented to two or three (of 10) sensory modalities, but they are not responsive to simple commands. Patients may vocalize (in the absence of tracheostomy) with moans, groans and grunts, but no recognizable words. This category overlaps and phases into the upper levels of the vegetative state and lower levels of the extreme vegetative state categories of the DRS (DRS scores of 24 to 26, respectively).
3	**2.90–3.49 Marked coma**	Patients are inconsistently responsive to stimulation presented to one (of 10) sensory modalities, and they are not responsive to simple commands. No vocalization (without tracheostomy). This category overlaps and phases into the middle levels of the extreme vegetative category of the DRS (DRS score 27 to 28).
4	**3.50–4.00 Extreme coma**	There is no responsivity to any of the sensory stimulation tests (of 10), no response to simple commands, and no vocalization (without tracheostomy). This category overlaps and phases into upper level of the extreme vegetative state category of the DRS (DRS score of 29).

Acknowledgement: Reprinted from Coma/Near Coma Scale (CNCS); Rappaport, M., Dougherty, A. M., & Kelting, D. L. (1992). Evaluation of coma and vegetative states. *Archives of Physical Medicine and Rehabilitation, 73*(7), 628–634, reprinted with permission from the American Congress of Rehabilitation Medicine and the American Academy of Physical Medicine and Rehabilitation and Elsevier.

Comprehensive Level of Consciousness Scale (CLOCS)

Stanczak et al. (1984)

Source

Detailed instructions and scoring procedures for the CLOCS are provided in Stanczak et al. (1984) and are reproduced below.

Purpose

The CLOCS is an objective, clinician-administered test, designed to measure a range of behaviours associated with impaired consciousness. It has been used with acute neurosurgical patients, mainly with traumatic brain injury (TBI) and stroke, as well as patients with neoplasms, hypoxia, drug overdose, hydrocephalus and cerebral infection.

Item description

The eight scales of the CLOCS examine posture, movement, responsiveness and communication, as well as four scales for eye and pupillary responses. Each of the eight scales contains between five and nine operationally defined levels, representing a hierarchy of responsiveness.

Scale development

Development of the CLOCS was in response to perceived limitations of the Glasgow Coma Scale (GCS). The authors identified a need to develop an instrument examining a wider range of behaviours than the GCS and one that was more sensitive to subtle changes in the patient. No information is provided in Stanczak et al. (1984), however, regarding scale development in terms of the item selection process or response format.

Administration procedures, response format and scoring

A torch to examine pupillary responses is the only equipment required to administer the CLOCS. In the initial validation study, the CLOCS was administered by a team of neurosurgical residents and neuropsychology doctoral candidates. It is described as being suitable for administration by technical and "paraprofessional" staff members. Administration time for experienced users is brief (3–5 mins).

Scores with a variable range are assigned to each of the levels within the eight scales. The level allocated, and corresponding score, is that which best represents the patient's functioning. The total score ranges from 0 to 48, with higher scores indicating a better level of functioning.

Psychometric properties

The validation sample for the CLOCS comprised 101 consecutive patients (mainly TBI) recruited from the neurosurgical service of the Baptist Memorial Hospital, in Memphis, Tennessee, USA (Stanczak et al., 1984). All patients (age $M = 44.75$ years, range 5–92) had a GCS score ≤ 13 ($M = 6.10$, $SD = 3.16$) and were within $M = 19.1$ hours ($SD = 17.3$) of symptom onset. They were assessed with the CLOCS and GCS every 12 hours for the first week and at less frequent intervals until any of the following occurred: GCS scores ≥ 13 on two consecutive occasions, discharge or death. Inter-rater reliability was established using three pairs of raters who jointly conducted (but independently scored) 20 evaluations. Temporal stability compared results of the initial assessment and re-evaluation after 12 hours. Validation included evaluations of a global assessment of consciousness by nurses using a 7-point scale from "coma depasse" to "alert and oriented". Predictive validity used the initial CLOCS score against an adapted nine-level version of the Glasgow Outcome Scale (GOS) made at discharge/death. A subsequent report (Johnston, Thomas, & Stanczak, 1996) used a subset of 43 out of the 101 patients from the Stanczak et al. study who had computerized tomography (CT) or electroencephalography (EEG) within 1 hour of CLOCS observation. Ratings from CT/EEG were converted to a 9-point Likert scale (from 0 = no change to 8 = profound change) by a rater who was blind to the CLOCS score. Results from Stanczak et al., unless otherwise stated, are shown in Box 2.2.

Box 2.2

Validity:	Criterion:
	Concurrent: with nurses' global ratings: $r = .71$
	Johnston et al.: with GCS: $r = .90$
	– with CT/EEG: $r = -.49$
	Predictive: initial CLOCS with GOS at discharge/death: $r = .58$
	Johnston et al.: in multiple regression analysis, CLOCS score was a significant individual contributor to prediction of outcome, after CT/EEG score, the final model accounting for 33% of the variance
	Construct:
	Internal consistency: Cronbach alpha: .86
Reliability:	Inter-rater: Median: $r = .96$
	Test–retest: 12 hours: $r_s = .89$
Responsiveness:	No information available

Comment

The CLOCS provides a reliable and valid measure of level of consciousness. Its very good psychometric properties are further enhanced with the exclusion of Scale 2 (Eye Position at Rest), and the authors recommend this scale be deleted for research studies. In comparing the CLOCS with the GCS, Stanczak et al. (1984) found that it had greater internal consistency and test–retest reliability, but comparable validity. Its very high correlation with the GCS ($r = .90$) also indicates that there is a great deal of overlap between the two instruments. One possible drawback of the CLOCS is the absence of cut-off scores for severity gradings, which has proved useful with other instruments such as the GCS for classifying patients and research participants into broad groupings for descriptive purposes (e.g., mild, moderate, severe degrees of injury). On the other hand, a particular strength of the CLOCS is the wide score range (0–48), which enables it to detect small changes in level of consciousness although a formal responsiveness study has not been reported.

Key references

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Comprehensive Level of Consciousness Scale

Stanczak et al. (1984)

Name: **Assessor:** **Date:**

SCALE 1: POSTURE

Instructions: Prior to any stimulation, observe the patient's posture and record the number of the most appropriate description.

4 Posture is under volitional control and is normally flexible
3 Normal periodic postural changes as in sleep
2 Asterixis, cerea flexibilitas, or rigid extension
1 No abnormal posture; muscle tonus is normal
0 No abnormal posture but muscle tonus is completely flaccid

SCALE 2: EYE POSITION AT REST

Instructions: Observe the patient's resting eye position and degree of conjugate movement of eyes. Record the number of the most appropriate description.

6 Midposition and conjugate
5 Full conjugate deviation
4 Resting deviation of the eyes below the horizontal meridian *OR* resting vertical, dysconjugate gaze
3 Conjugate ocular deviation in which the eyes cannot be brought back past the midline
2 Unilateral inward or outward deviation
1 Eyes converge
0 Skew deviation

SCALE 3: SPONTANEOUS EYE-OPENING

Instructions: Prior to any stimulation, observe the patient for spontaneous eye-openings. If none, try to elicit eye-openings by presenting the following *verbal stimuli* in order: 1) speaking the patient's name, and 2) shouting the patient's name. If these mild stimuli fail, the following *moderate stimuli* should be applied: 1) shaking the patient lightly, 2) repeated light slapping of the medial aspect of the patient's arms, and 3) shaking the patient vigorously taking care not to dislodge any life support systems or to exacerbate any injuries. If the mild and moderate stimuli fail to elicit eye-opening, the following *noxious stimuli* should be applied: 1) rubbing the sternum vigorously with your thumb, 2) pressing on the nailbeds of fingers of both the patient's hands, and 3) squeezing the webbed tissue between the thumb and index finger on both the patient's hands. Stimulation is terminated when a recordable response is elicited. If none of these procedures elicits eye-opening assign a score of zero for this scale.

4 Volitional control of eye-opening
3 Eye-opening in response to mild (verbal) stimuli
2 Eye-opening only in response to moderate stimuli
1 Eye-opening only in response to noxious stimuli
0 No spontaneous or elicited eye-opening

SCALE 4: GENERAL MOTOR FUNCTIONING

Instructions: Prior to any stimulation, observe the patient's spontaneous movements. If no spontaneous movements are observed, a knowledgeable informant should be questioned to determine if spontaneous movements have been observed during the previous 6-hour period. Record the number of the most appropriate description of the patient's BEST performance.

6 Normal spontaneous movements within the limits of the patient's physical abilities
5 Psychomotor excitation *OR* marked torpor
4 Any of the following: yawning, sneezing, spontaneous swallowing, hiccoughing, sucking, or gnawing on lower lip, rhythmic tongue protrusions, kissing movements, and/or chewing movements
3 Polishing movements by the hand on the thigh, abdomen, or chest, *OR* stirring motions and scratching of the skin or bed, *OR* flexion and extension of the toes and/or ankles, *OR* fine picking movements of the fingers
2 Multifocal or rhythmic myoclonus or spasms of the extremities
1 Athetoid or ballistic movements of the fingers, wrists, elbows, toes, ankles, or knees, *AND*/*OR* torsions of the shoulders, hips, spine, neck, or face, *OR* periodic seizure activity
0 No spontaneous motor movements

SCALE 5: ABNORMAL OCULAR MOVEMENTS

Instructions: Observe the patient's ocular movements and record the number of the most appropriate description.

6 None
5 Slow, random horizontal movements that may vary from conjugate to dysconjugate
4 Refractory nystagmus
3 Convergence nystagmus
2 Ocular bobbing *OR* nystagmoid jerking of either eye in a lateral, vertical, or rotational direction
1 Slow, irregular eye movements that are bilateral and sometimes reciprocal such that one eye may move downward and outward while the other moves upward and inward
0 Complete absence of ocular motility

SCALE 6: PUPILLARY LIGHT REFLEXES

Instructions: Pupillary reactivity to a strong light source should be noted, and the number of the most appropriate description should be recorded.

7 Normal direct and consensual light reflexes
6 Unilateral absence of direct light reflex
5 Unilateral absence of direct and consensual light reflexes
4 Bilateral absence of direct and consensual light reflexes
3 Hippus
2 Pontine (pinpoint) pupils
1 Eyes at midposition, 4–5 mm in diameter, and fixed to all stimuli *OR* pupils may be slightly irregular and/or slightly unequal
0 Wide pupillary dilation and fixed to all stimuli *OR* bilaterally small (pinpoint) pupils which are fixed to all stimuli

SCALE 7: GENERAL REPONSIVENESS

Instructions: The following definitions are appropriate to this scale: *Arousal*: any intelligible verbalization and/or eye-opening coupled with the apparently volitional establishment of reliable eye-contact with the examiner; concomitant motor activity may or may not be observed. *Mild stimulation*, *moderate stimulation*, and *noxious stimulation*: same as in Scale 3. Record the number of the description which most adequately reflects the patient's response.

8 The person is fully aroused and alert or, if asleep, arouses and attends to the examiner following only mild or moderate stimulation. The arousal outlasts the duration of the stimulus
7 The person is aroused by mild or moderate stimulation but, upon cessation of stimulation, returns to his/her former state *OR* the patient displays marked psychomotor agitation shortly after the stimulus onset
6 The patient is aroused only by noxious stimulation
5 In response to noxious stimulation, the patient displays a purposeful, coordinated withdrawal and/or a typical facial grimace. There is no arousal
4 In response to noxious stimulation, the patients display a gross, disorganized withdrawal. There is no facial grimace or arousal
3 In response to noxious stimulation, the patient displays only a feeble, disorganized withdrawal *OR* flexion. There is no arousal or facial grimace
2 Any decorticate rigidity
1 Any decerebrate rigidity
0 Total absence of discernible motor activity even in response to noxious stimulation

SCALE 8: BEST COMMUNICATIVE EFFORT

Instructions: Observe the patient's communicative efforts and record the number of the description that most accurately reflects the patient's BEST response. Additional information regarding communicative efforts during the previous 6-hour period may be solicited from a knowledgeable informant.

7 Normal communication is possible through speech, writing, gesturing, etc.
6 Profuse spontaneous or elicited verbalizations (signs/gestures). The communication is intelligible but may be bizarre, jargonistic, and/or perseverative
5 The patient responds to verbal, written, or signalled instructions with spontaneous but unintelligible or poorly articulated verbalizations (sign/gestures) or in a coded manner such as eye-blinking, finger-tapping, or hand-squeezing. If intubated, the person responds appropriately to commands
4 The patient spontaneously vocalizes, verbalizes, makes signs, or gestures but gives no indication that he /she comprehends any form of receptive language
3 The patient visually tracks an object passed through his/her visual field and/or turns his/her head towards the examiner as if wishing to communicate *OR* the patient generates spontaneous moaning or muttering coupled with reliable eye contact or searching behaviours
2 Spontaneous, random muttering or moaning only
1 Muttering or moaning in response to noxious stimulation
0 No elicited or spontaneous vocalizations, searching behaviours, or eye-contact

GLOSSARY

ASTERIXIS: intermittent lapses of an assumed posture
ATHETOID: slow, sinuous, writhing movements
BALLISTIC: violent, flinging movements
CEREA FLEXIBILITAS: waxy flexibility commonly seen in catatonia
CONVERGENCE NYSTAGMUS: slow, drifting ocular divergence followed by a quick convergent jerk; may be interspersed with refractory nystagmus
DECEREBRATE RIGIDITY: extended, adducted (drawn towards the median plane), and internally rotated upper limbs; bilaterally extended and plantar-flexed lower limbs; opisthotonos (head and heels bent backward and the body bowed forward) and/or jaw-clenching may be observed
DECORTICATE RIGIDITY: upper limbs are flexed at the elbows, wrists, and fingers, and are adducted (drawn towards the median plane) at the shoulders; the lower limbs are extended, plantar-flexed, and internally rotated
HIPPUS: eyes at midposition, 5–6 mm in diameter, round, and regular but spontaneously fluctuate in size and may show abnormal exaggeration of rhythmic contraction and dilation independent of changes in illumination
NYSTAGMUS: involuntary, rapid movement of the eyeball
OCULAR BOBBING: conjugate, brisk, downward eye movements followed by a slower return to the primary position in a kind of bobbing action
REFRACTORY NYSTAGMUS: irregular jerks of the eye backward into the orbit
SKEW DEVIATION: one eye looking upward while the other looks downward
TORPOR: sluggishness, motor retardation
TORSION: twisting

Acknowledgement: Reprinted from Stanczak, D. E. et al. (1984). Assessment of level of consciousness following severe neurological insult. *Journal of Neurosurgery, 60*, 955–960, Figure 1, p. 956, reprinted by permission of the American Association of Neurological Surgeons.
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Glasgow Coma Scale (GCS)

Teasdale and Jennett (1974)

Source

The GCS was originally described in Teasdale and Jennett (1974). The typical recording chart appears in Jennett and Teasdale (1981), is available on the Internet Stroke Center website (http://www.strokecenter.org), and is also reproduced below.

Purpose

The GCS is an objective, clinician-administered test, designed to assess depth and duration of impaired consciousness and coma arising from any medical condition. These include neurological conditions (such as cerebral infections, stroke and traumatic brain injury, TBI), as well as non-neurological conditions that may result in altered levels of consciousness (e.g., diabetic ketosis, drug overdose, renal failure). The aim was to develop a bedside examination that could be repeated throughout a 24-hour period to monitor change in level of consciousness.

Item description

The GCS examines hierarchical levels of functioning in three domains: Eye opening, Verbal response and Motor response. There are four levels of Eye opening, ranging from the lowest level, no eye opening, not even in response to pain, through to the highest level, spontaneous eye opening. Five levels of Verbal response range from no verbal response, not even incomprehensible sounds, through to oriented to person, place and time for year, season and month. Six levels of Motor response range from no motor response, not even in response to pain, through to obeying commands, such as "squeeze my hand".

Scale development

Development of the GCS arose in an effort to improve methods of assessment of impaired consciousness available at that time, many of which used unstructured observations and descriptive labels (e.g., stupor, torpor, obtunded) that did not have clear behavioural descriptors allowing reliable assessment. Limited information is available regarding the developmental process of the GCS, but the three components selected for the GCS (eye opening, verbal and motor responses) feature commonly in reports of impaired consciousness. Levels of response were independently evaluated in each component and graded in rank order of the degree of dysfunction (four for Eye opening, five for Verbal and six for Motor). The Motor domain initially contained five levels, but was subsequently increased to six by subdividing flexion to take account of withdrawal versus abnormal flexion (Teasdale & Jennett, 1976).

Teasdale and Jennett (1974) initially resisted a definition of "either consciousness or coma in absolute terms" (p. 82), although they used an operational definition of coma as "a patient who showed no eye opening, who did not obey commands, nor give any comprehensible verbal response" (Jennett & Teasdale, 1977, p. 880). Early investigations into the GCS focused on analysis of these three components separately, but Jennett and Teasdale (1977) also recognized that a summed score could provide a useful index of overall responsiveness of the patient. Based on analysis of GCS scores from 700 patients in the International Data Bank (Jennett & Teasdale, 1977), later increased to 1000 patients, they further defined the presence of coma in relation to a summed GCS score (Jennett & Teasdale, 1981, p. 81):

> In the range from 3 to 15 there is not a point that discriminates absolutely between patients in coma (by our definition) and those who are more responsive than this. However, all combinations that sum to 7 or less define coma, as do . . . 90 percent of all observations summing to 8 or less, and none of those that add up to 9 or more.

By convention, total GCS scores can be classified into severity groupings (mild, moderate and severe), but no information is available regarding the methodology of this determination (see Teasdale, 1995).

Administration procedures, response format and scoring

No special materials are required to administer the GCS. The authors aimed to develop a scale that did not require special training for the clinician, but even so, clinicians need to be experienced in assessing altered states of consciousness to ensure reliability, as the results of Rowley and Fielding (1991) demonstrated. Time to administer the GCS is very quick – a matter of a few minutes. Factors impeding administration (e.g., eye swelling, intubation, splints) are recorded. When responses are variable (e.g., differences between limb movements) the best response is recorded.

The total GCS score ranges from 3 to 15, and scores for the domains can also be reported separately in notation form: for example, E4+V1+M3 referring to scores for Eye opening, Verbal response and Motor response respectively. Total scores can also be converted to injury severity groupings: mild (GCS scores 13–15), moderate (scores 9–12), and severe (scores ≤ 8).

Psychometric properties

In spite of the large literature on the GCS, relatively little information is available on its psychometric properties. Earlier studies by the test developers focused on examining specific psychometric features, such as inter-rater reliability (Teasdale, Knill-Jones, & Van der Sande, 1978). Although results were positive, more specific questions posed by subsequent research groups, have tempered the earlier findings. For example, Rowley and Fielding (1991) examined inter-rater reliability of the GCS with four groups of nurses with varying degrees of training and experience in using the GCS. Experienced/trained nurses had higher inter-rater reliability ($r = .87–1.0$) for all components than student nurses without training or experience on neurosurgical wards ($r = .76–1.0$). Discrepancies were particularly noted in scoring the more difficult mid-range patients where agreement was substantially lower (8–14%) than at the extremes (97%).

Predictive validity of the GCS was also the subject of a number of early studies. Jennett, Teasdale, Braakman, Minderhoud, and Knill-Jones (1976) examined prediction on Glasgow Outcome Scale (GOS) at 6 months post-trauma from GCS data collected in the acute stages after TBI in patients recruited from the Institute of Neurological Sciences, Glasgow, UK ($n = 428$) and two centres in the Netherlands ($n = 172$). It is noted, however, that Teasdale and Jennett (1976) had already placed caveats on the predictive validity of the GCS, recommending that the GCS score should be used in combination with other variables, such as age and brainstem function, and they further asserted that "impaired consciousness alone . . . is not enough to make accurate prediction in individual patients" (Jennett & Teasdale, 1977, p. 881). The low to moderate correlation coefficients between GCS scores in isolation and outcome measures such as the Functional Independence Measure have been subsequently confirmed by independent research groups (e.g., Zafonte, Hammond, Mann, Wood, Black, & Millis, 1996).

There is considerable evidence to support the construct validity of the GCS. Outcome studies in which participants have been stratified according to the three GCS severity bands have demonstrated the differential outcomes for those whose initial injuries were mild, moderate or severe. Thornhill, Teasdale, Murray, McEwan, and Roy (2000), for example, followed up 549 patients with head injury admitted to five general hospitals in Glasgow in a 12-month period (66% mild with GCS 13–15, 18% moderate with GCS 9–12, 13% severe with GCS ≤ 8, 3% unclassified).

In the course of validating other instruments, psychometric data are also furnished for the GCS, and concurrent validity has been demonstrated by Majerus, Van der Linden, and Shiel (2000) with the Wessex Head Injury Matrix (WHIM), by Wijdicks, Bamlet, Maramattom, Manno, and McClelland (2005) with the Full Outline of UnResponsiveness (FOUR) score and so forth. A comprehensive psychometric study in a single sample was conducted by Stanczak et al. (1984) to validate the Comprehensive Level of Consciousness Scale (CLOCS; also described in this chapter). The sample comprised 101 consecutive admissions to the neurosurgical service of the Baptist Memorial Hospital, Memphis, Tennessee, USA. Patients were aged $M = 44.8$ years ($SD = 24.5$, range 5–92), mainly with TBI and stroke, and assessed within hours of symptom onset. All had GCS scores of 13 or less. Inter-rater reliability was determined using three pairs of independent raters making 20 joint evaluations. Temporal stability was established by comparing initial evaluation with reassessment 12 hours later. Concurrent validity was examined with nurses' ratings on a global 7-point scale to assess level of consciousness from "coma depasse" to "alert and oriented". Predictive validity was examined with initial GCS scores and a 9-level version of the Glasgow Outcome Scale at discharge/death. Results of the Stanczak et al. study, except where otherwise stated, are shown in Box 2.3.

Box 2.3

Validity:	Criterion: *Concurrent:* with nurses' ratings: $r = .68$ Majerus et al.: with initial WHIM: $r = .83$, with final WHIM: $r = .95$ Wijdicks et al.: with FOUR: $r_s = .92$ *Predictive:* initial GCS with GOS at discharge/death: $r = .56$ Jennett et al.: GCS in first 24 hours with death/persistent vegetative state vs survival 97% accuracy – GCS in first 3 days with death/persistent vegetative state vs severe disability vs moderate disability/good recovery 97% accuracy Construct: *Internal consistency:* Cronbach alpha: .69 *Discriminant:* Thornhill et al.: at 12 month follow-up, – 42% of severe vs 22% of mild and 28% of moderate had problems with activities of daily living inside the home – 67% of severe vs 34% of mild and 38% of moderate had such problems outside the home – 82% of severe vs 58% of mild and 66% of moderate experienced physical problems – 76% of severe vs 43% of mild and 49% of moderate experienced cognitive problems; all $p < .01$
Reliability:	Inter-rater: Median: $r = .95$ Test–retest: 12 hours: $r_s = .85$
Responsiveness:	No information available

Derivatives of the GCS

The GCS is very widely used and has spawned a number of other applications, two of which are described below.

Paediatric Glasgow Coma Scale (PGCS); Simpson and Reilly (1982)

As noted by Jennett and Teasdale (1977), there are several reasons other than coma why patients may not speak, and they highlighted the special case of children. Simpson and Reilly (1982) amended the GCS for children. They described motor and verbal responses in relation to developmental stages from babies < 6 months of age to age 5 years and a subsequent publication provided validity data (Simpson, Cockington, Hanieh, Raftos, & Reilly, 1991). Their descriptions are shown in Box 2.4.

The British Paediatric Neurological Association (2001) (http://www.bpna.org.uk; accessed 27 April, 2008) further revised the verbal response category for children younger than 5 years as follows:

V5. Alert, babbles, coos, words or sentences to usual ability
V4. Less than usual ability, irritable cry
V3. Cries to pain
V2. Moans to pain
V1. No vocal response to pain

Glasgow Coma Scale – Extended (GCS-E); Nell, Yates, and Kruger (2000)

An extension to the GCS was published by Nell et al. (2000) known as the GCS-E. The aim of the GCS-E is to capture variations within the mild injury group, that is, those scoring 13 to 15 on the GCS. A coded set of "behavioural landmarks", which estimates the duration of post-traumatic amnesia, is added to the GCS score. The 8-point Amnesia Scale is reproduced below. The authors note that when the GCS score is 12 or less, it is seldom possible to use the Amnesia Scale, but other procedures are available and suited to this purpose (see Section 3 of this chapter for a selection of instruments to measure post-traumatic amnesia). Scores 0 to 7 derived from the Amnesia Scale of the GCS-E can be used as an "optional diagnostic variable" by entering the score after a colon placed after the GCS score. Thus a person scoring 13 on the GCS who also has an amnesia of approximately 1 hour would be coded as 13:5. The GCS-E uses a training manual, which includes a proficiency test.

Comment

The GCS established a landmark in the evaluation of patients with altered states of consciousness. Some reports, however, have raised concerns about the psychometric properties of the GCS (see the systematic review of Prasad, 1996). A number of these issues are easily addressed (e.g., training for novice examiners to

Box 2.4

Age	*Best verbal response*	*Age*	*Best motor response*	*Age*	*Maximum score*
0–6 mths	Cries (score 2)	0–6 mths	Flexion (score 3)	0–6 mths	9
> 6–12 mths	Noises (score 3)	6 mths – 2 yrs	Localizes pain, but does not obey (score 4)	> 6–12 mths	11
1–5 yrs	Words (score 4)	> 2 yrs	Obeys commands	> 1–2 yrs > 2–5 yrs	12 13
> 5 yrs	Oriented (aware that in hospital – score 5)			> 5 yrs	14

improve inter-rater reliability), and others (e.g., low internal consistency) may be expected given that the GCS comprises only three disparate components that are evaluated independently. An important limitation is the incomplete assessment that results when patients are intubated, paralysed or sedated. In terms of predictive validity, the GCS was developed for emergency medicine, where arguably the critical prediction is one of survival and level of function early post-trauma, which the GCS does well. Other measures are probably better suited as predictors of detailed functional outcomes in rehabilitation samples. Notwithstanding criticisms of the GCS, as Nell et al. (2000) note: "The benefits of international acceptance, familiarity, ease of use, and a high degree of inter-rater reliability weigh the balance heavily against the introduction of alternative methods of assessing level of consciousness" (p. 614).

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Summary score sheet for the Glasgow Coma Scale

Teasdale and Jennett (1974)

Name:

		Date:							
		Time:							
		Assessor:							
	Spontaneous	4							
EYE	To speech	3							
OPENING	To pain	2							
	None	1							
	Oriented	5							
BEST	Confused	4							
VERBAL	Inappropriate words	3							
RESPONSE	Incomprehensible sounds	2							
	None	1							
	Obeys commands	6							
BEST	Localizes pain	5							
MOTOR	Withdraws	4							
RESPONSE	Flexion to pain	3							
	Extension to pain	2							
	None	1							
		TOTAL SCORE:							

Acknowledgement: Adapted from Teasdale, G., & Jennett, B. (1974). Assessment of coma and impaired consciousness: A practical scale. *The Lancet*, *304*(7872), 81–84, figure from p. 83, reprinted by permission of *The Lancet*, and Jennett, B. (1976). Assessment and prognosis of coma after head injury. *Acta Neurochirurgica*, *34*(1–4), 45–55, reprinted by permission of Springer-Verlag.

Items of the Amnesia Scale for Glasgow Coma Scale – Extended

Nell, Yates, and Kruger (2000)

Name:	**Assessor:**	**Date:**

7	No amnesia: client can remember impact, can remember falling and striking a solid surface, etc.
6	Amnesia for 30 minutes or less: client regained consciousness while still in vehicle, in street at scene of incident, etc.
5	Amnesia of ½ hour to 3 hours: remembers being loaded into ambulance, in ambulance on way to hospital, arriving at emergency room, admission to ward, etc.
4	Amnesia of 3 to 24 hours: determine duration by content of the first memory, which will be for an event in the ward or other hospital procedure
3	Amnesia of 1 to 7 days
2	Amnesia of 8 to 30 days
1	Amnesia of 31 to 90 days
0	Amnesia greater than 3 months
X	Cannot be scored, e.g., can speak but responses are inappropriate or unintelligible, cannot speak because unconscious, intubated, facial fractures, etc.

Acknowledgement: From Nell, V., Yates, D. W., & Kruger, J. (2000). An extended Glasgow Coma Scale (GCS-E) with enhanced sensitivity to mild brain injury. *Archives of Physical Medicine and Rehabilitation*, *81*(5), 614–617, Table 1, p. 615, reprinted with permission of the American Congress of Rehabilitation Medicine and the American Academy of Physical Medicine and Rehabilitation and Elsevier.

JFK Coma Recovery Scale – Revised (CRS-R)

Giacino and Kalmar (2004)

Source

An appendix to Giacino, Kalmar, and Whyte (2005) provides the Response Profile to the JFK CRS-R, which is also reproduced below. The actual scale items, manual and other information are available on the website of the Center for Outcome Measurement in Brain Injury (http://www.tbims.org/combi/crs/index.html).

Purpose

Both the original CRS (Giacino, Kezmarsky, DeLuca, & Cicerone, 1991) and the revised scale provide an objective, clinician-administered test of behavioural and cognitive responses of patients in coma, the vegetative state (VS) and minimally conscious state (MCS). The CRS/CRS-R was designed for patients with ABI with Rancho Los Amigos Levels of Cognitive Functioning Scale (LCFS) from Level I (no response) to Level IV (confused, agitated). Development of the scale was conducted with patients with anoxia, stroke, traumatic brain injury (TBI) and tumour. The CRS-R is intended for diagnosis, rehabilitation and longer-term planning, and monitoring patient progress and treatment effectiveness.

Item description

The CRS-R comprises six subscales: Auditory, Visual, Motor, Oromotor/verbal, Communication, and Arousal. Within each subscale there is a hierarchy of levels, representing increasing complexity of responses. The responses are elicited with standardized instructions. The lowest level responses within a subscale represent reflex activity and the highest represent "cognitively mediated behaviors". For example, items in the Auditory subscale range from the lowest item (no response, not even auditory startle after presentation of a loud noise above patient's head and out of view) to the highest (passing all four trials of the request to look at one of two simultaneously presented common objects).

Scale development

Development of the original CRS was in response to a number of limitations of traditional instruments used at that time to measure recovery of consciousness. Prominent among the limitations were poor prognostic utility beyond the acute phase of recovery and insensitivity to subtle changes in functioning. Item development for the CRS used an initial pool of 41 items generated by a multidisciplinary group with expertise in acute brain injury rehabilitation. Six items considered difficult to score were eliminated, leaving 35 items. The scale was subsequently revised to improve its clinical utility and psychometric properties, as well as to incorporate criteria of the Aspen Neurobehavioral Conference Workgroup (Giacino et al., 2002).

Administration procedures, response format and scoring

Test materials (everyday objects such as comb, ball, mirror) are required for administration of the CRS-R. Standardized test procedures for administration are described in the manual. Alternative items are provided for a range of response modalities, thereby allowing examination of a domain, even if the patient cannot respond within a particular modality (e.g., presence of a tracheostomy tube preventing speech). Administration time is 20 to 25 minutes, and new examiners are trained with a standard training protocol.

Operationally defined criteria describe various levels of response complexity within each of the subscales, and each level is assigned a score. The total score ranges from 0 to 23, revised from 0 to 24 in Giacino et al. (2005) (level 3 for Orientation in the Communication Scale has been excluded – Personal communication: J. T. Giancino, 27 May, 2006). Higher scores reflect better performance.

Scores can be converted to a classification of VS, MCS or emergence from MCS using the Response Profile. Five domains are used for this purpose, with the following algorithm: *Emergence from VS* requires achievement of, at minimum, *all* of the following: (i) reproducible movement to command, (ii) visual fixation,

(iii) motor localization to noxious stimuli, (iv) intelligible verbalization and (v) intentional (even if non-functional) communication. *Emergence from MCS* requires additional criteria: *either* (i) functional object use *and/or* (ii) accurate, functional communication.

Psychometric properties

A sample of 80 patients (age $M = 38.86$ years, $SD = 13.18$) recruited from a specialized Coma Intervention Program within an inpatient rehabilitation centre in the USA was examined (Giacino et al., 2005). A subset of 20 out of the 80 patients was studied prospectively for the reliability study, and data from the remaining 60 patients were drawn from an existing database and combined with the prospective group in a validation study. Cause of ABI was mainly stroke or TBI, and time post-onset was approximately 2 months. Inter-rater and test–retest reliability were examined with separate and independent examinations of the patients by two raters. The CRS-R demonstrated an even spread of scores across the range, without floor or ceiling effects. Establishing the diagnostic accuracy of the CRS-R (VS, MCS and emergence from MCS (MCS+)) was hampered by the absence of an independent criterion. Correspondence with Disability Rating Scale (DRS) classifications, however, was 87.5%. Giacino et al. (2005) argued that the CRS-R was more sensitive than the DRS in that 10 out of 80 cases were classified as MCS on the CRS-R, but VS on the DRS. In each case, visual pursuit was intact, a defining feature of emergence from VS, but this domain is not examined on the DRS. Data on responsiveness, using the CRS, come from the case series of Passler and Riggs (2001) who treated five patients in VS with bromocriptine. CRS scores improved substantially over a 3-month treatment period, and the authors noted that the CRS was "able to document even subtle changes" (p. 314), with a large effect size. Results from Giacino et al. (2005), except where otherwise stated, are shown in Box 2.5.

Box 2.5

Validity:	Criterion: *Concurrent:* with DRS: $r_s = -.90$ – with original CRS: $r_s = .97$ *Predictive:* Giacino & Croll, 1991 (cited in Kalmar & Giacino, 2005): scores on original CRS subscales (Motor, Communication and Auditory) at 1–3 months predicted DRS outcome at 12 months Construct: *Internal consistency:* Cronbach alpha: Total score: .83 *Discriminant:* able to distinguish among diagnostic categories (VS $n = 5$, MCS $n = 13$, MCS+ $n = 2$, with good inter-rater and test–retest reliability – see below)
Reliability:	Inter-rater: Total score: $r_s = .84$ – Diagnostic agreement for VS vs MCS vs MCS+: $k = .60$ – Subscale range for VS vs MCS: $k = .58$–$.88$ (with $k \geq .75$ for 4/5 subscales) Test–retest: 36 hours: Total score: $r_s = .94$ – Diagnostic agreement for VS vs MCS vs MCS+: $k = .82$ – Subscale range for VS vs MCS: $k = .23$–1.0 (with $k \geq .6$ for 4/5 scales, $< .4$ for 1/5 – Oromotor/Verbal $k = .23$)
Responsiveness:	Passler & Riggs: initial CRS score $M = 8.2$ ($SD = 4.5$) vs highest score with treatment $M = 20.2$ ($SD = 4.6$); $d = 2.7$

Comment

The CRS-R is a carefully developed instrument, which incorporates revisions in line with recent diagnostic recommendations of the Aspen Workgroup on the MCS. Giacino et al. (2005) and Kalmar and Giacino (2005) express reservations about psychometric properties of individual subscales of the CRS-R and suggest that such scores should be used with caution until further data are available. Yet in comparison with other similar scales, psychometric properties of the CRS-R fare very well – although the Visual subscale had moderate inter-rater reliability and the Oromotor/verbal subscale showed poor temporal stability, reliability was otherwise good to excellent. An appealing feature of the CRS-R is its diagnostic capacity in distinguishing among VS, MCS, and emergence from MCS. This facility gives the CRS-R an advantage over other scales that do not have this feature. Giacino and Kalmar (2004) point to the "alarming" rates of misdiagnoses of disorders of consciousness, the most common error being diagnosis of VS in patients who function at a higher level, and in this regard the CRS-R has the capacity to improve diagnostic accuracy.

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Profile for the JFK Coma Recovery Scale – Revised

Giacino and Kalmar (2005)

Name:

SCORE		Date: / Assessor:								
	AUDITORY FUNCTION SCALE									
4	Consistent movement to command *									
3	Reproducible movement to command *									
2	Localization to sound									
1	Auditory startle									
0	None									
	VISUAL FUNCTION SCALE									
5	Object recognition *									
4	Object localization: reaching *									
3	Visual pursuit *									
2	Fixation *									
1	Visual startle									
0	None									
	MOTOR FUNCTION SCALE									
6	Functional object use †									
5	Automatic motor response*									
4	Object manipulation *									
3	Localization to noxious stimulation *									
3	Flexion withdrawal									
1	Abnormal posturing									
0	None/flaccid									
	OROMOTOR/ VERBAL FUNCTION SCALE									
3	Intelligible verbalization *									
2	Vocalization/oral movement									
1	Oral reflexive movement									
0	None									
	COMMUNICATION SCALE[1]									
2	Functional: accurate †									
1	Non-functional: intentional *									
0	None									
	AROUSAL SCALE									
3	Attention									
2	Eye opening without stimulation									
1	Eye opening with stimulation									
0	Unarousable									
	TOTAL SCORE									

* Denotes MCS

† Denotes emergence from MCS

1. Communication Scale: score 3 (oriented) appears in Giacino et al. (2005) but is omitted from the Profile because it is no longer part of the scoring system (Personal communication: J. T. Giacino, 27 May, 2006).

Acknowledgement: From Giacino, J. T., Kalmar, K., & Whyte, J. (2005). The JFK Coma Recovery Scale – Revised: Measurement characteristics and diagnostic utility. *Archives of Physical Medicine and Rehabilitation*, *85*(12), 2020–2029, reprinted with permission of the American Congress of Rehabilitation Medicine and the American Academy of Physical Medicine and Rehabilitation and Elsevier.

Rancho Los Amigos Levels of Cognitive Functioning Scale (LCFS)

Hagen, Malkmus, and Durham (1972)

Source

The LCFS, also referred to as the Rancho Los Amigos Scale, is available in Appendix C of Hagen, Malkmus, Durham, and Bowman (1979). Additionally, the LCFS appears on the website of the Center for Outcome Measurement in Brain Injury (http://www.tbims.org/combi/lcfs/index.html), and is reproduced below.

Purpose

The LCFS is a clinician rating scale, using clinical observations to judge and classify level of cognitive functioning in overall terms. It was designed for people with traumatic brain injury (TBI), focusing on the post-acute stage until emergence from post-traumatic amnesia.

Item description

The eight hierarchical categories of the LCFS are as follows: I: no response; II: generalized response; III: localized response; IV: confused, agitated response; V: confused, inappropriate, non-agitated response; VI: confused, appropriate response; VII: automatic, appropriate response; VIII: purposeful, appropriate response. Each level is accompanied by a detailed behavioural description (see below).

Scale development

Limited information is available on the development of the LCFS. According to Flannery (1995), Malkmus, Booth, and Kodimer (1980; cited in Flannery, 1995) ascribed development of the LCFS to the observations made by their interdisciplinary team of 1000 patients during recovery from TBI. The structure and content of the LCFS were (Flannery, 1995, p. 47):

> based on the assumption that observation of the type, nature and quality of the patient's behavioural responses can be used to estimate the cognitive level at which the patient is functioning. Furthermore, it was theorized that, if recovery was possible, cognitive functioning would be regained following a definable and predictable pattern.

Administration procedures, response format and scoring

There is no administration of the LCFS per se; rather the clinician classifies the patient into the category of best fit, based on behavioural observations and knowledge of the patient. Completion of the LCFS itself is thus very quick. The LCFS yields a classification at one of eight levels.

Psychometric properties

Gouvier, Blanton, LaPorte, and Nepomuceno (1987) published the first psychometric report on the LCFS, comparing it with the Disability Rating Scale (DRS). They examined 40 patients (age $M = 24.8$ years, range 5–69) with TBI admitted to an acute rehabilitation centre in Birmingham, Alabama, USA. Ratings were made 4 days per week until discharge, with pairs of three raters making independent ratings on the 4th day of each week. Test–retest reliability was determined by summing all scores for the odd days and comparing those with the sum of scores for the even days. Validation instruments were administered at discharge and comprised the Stover-Zeiger Scale (SZS), Glasgow Outcome Scale (GOS), and a 10-category expanded GOS (E-GOS). Talbot and Whitaker (1994) used the LCFS to examine the effect of sensory stimulation in a case series of seven patients (aged 19–55 years) who had been in an "altered state of consciousness" for more than 1 month. The individual scores presented in the report for each patient enable an assessment of responsiveness of the LCFS, and statistical analysis was conducted on the data by the author. Box 2.6 presents a summary of the findings from Gouvier et al., except where otherwise indicated.

Box 2.6

Validity:	Criterion: *Concurrent:* Discharge LCFS with SZS: $r_s = .73$ – with GOS: $r_s = .76$ – with E-GOS: $r_s = .79$ *Predictive:* Initial LCFS with discharge SZS: $r_s = .59$ – with discharge GOS: $r_s = .57$ – with discharge E-GOS: $r_s = .68$
Reliability:	Inter-rater: Mean $r_s = .89$ (rater range .87–.94) Test–retest: 1 day: $r_s = .82$
Responsiveness:	Talbot & Whitaker: Pre-treatment LCFS $M = 2.29$ ($SD = 0.49$) vs post-treatment $M = 4.43$ ($SD = 0.98$); $z = -2.46$, $p < .02$, $d = 4.37$

Derivatives of the LCFS: Levels of Cognitive Functioning Assessment Scale (LCFAS); Flannery (1995)

Flannery (1995) used the LCFS to develop the slightly differently named LCFAS, using the first five LCFS levels. The narrative descriptions of the LCFS levels were converted to a list of 41 behavioural descriptors. The clinician uses the checklist of items to endorse those observed in the patient and "visual inspection" is used to determine the category in which most behaviours are endorsed. This method resulted in very good inter-rater reliability ($k = 1.0$ with neuropsychology experts, $k = .84$ with student nurses) and 2-week test–retest reliability ($k = .86$ with student nurses).

Comment

Although the LCFS provides a quick overall summation of the patient's level of cognitive functioning and is commonly used as a benchmark, it has a number of limitations. Horn, Sheil, McLellan, Campbell, Watson, and Wilson (1993) point to the problem that a patient may fluctuate between levels simultaneously, depending on environmental factors (e.g., Level IV: confused, agitated vs Level V: confused, non-agitated). Another drawback of the LCFS is that it has a limited number of response categories, and as such, the scale is not suited to measuring very small gradations of change in the patient, even though it is responsive to changes on a broader scale. Furthermore, Gouvier et al. (1987) were critical of the psychometric properties of the LCFS which were lower than the DRS on all counts. They concluded that it "makes it difficult to endorse the continued use of the LCFS when a superior evaluation instrument is so readily available" (p. 96). Even so, the LFCS has survived this criticism, and 14 years later was described as having "almost universal acceptance in the United States because of its simplicity and clinical utility" (Hall, Bushnik, Lakisic-Kazazic, Wright, & Cantagallo, 2001, p. 369).

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Rancho Los Amigos Levels of Cognitive Functioning Scale

Hagen, Malkmus, and Durham (1972)

I. NO RESPONSE

Patient appears to be in a deep sleep and is completely unresponsive to any stimuli presented to him.

II. GENERALIZED RESPONSE

Patient reacts inconsistently and non-purposefully to stimuli in a non-specific manner.

Responses are limited in nature and are often the same regardless of stimulus presented. Responses may be physiological changes, gross body movements and/or vocalization. Often the earliest response is to deep pain. Responses are likely to be delayed.

III. LOCALIZED RESPONSE

Patient reacts specifically but inconsistently to stimuli.

Responses are directly related to the type of stimulus presented as in turning head toward a sound, focusing on an object presented. The patient may withdraw an extremity and/or vocalize when presented with painful stimulus. He may follow simple commands in an inconsistent, delayed manner, such as closing his eyes, squeezing or extending an extremity. Once external stimuli are removed, he may lie quietly. He may also show a vague awareness of self and body by responding to discomfort by pulling at nasogastric tube or catheter or resisting restraints. He may show a bias toward responding to some persons (especially family, friends) but not to others.

IV. CONFUSED-AGITATED

Patient is in a heightened state of activity with severely decreased ability to process information.

He is detached from the present and responds primarily to his own internal confusion. Behaviour is frequently bizarre and non-purposeful relative to his immediate environment. He may cry out or scream out of proportion to stimuli even after removal, may show aggressive behaviour, attempt to remove restraints or tubes or crawl out of bed in a purposeful manner. He does not, however, discriminate among persons or objects and is unable to cooperate directly with treatment efforts. Verbalization is frequently incoherent and/or inappropriate to the environment. Confabulation may be present; he may be euphoric or hostile. Thus gross attention to environment is very short and selective attention is often nonexistent. Being unaware of present events, patient lacks short-term recall and may be reacting to past events. He is unable to perform self-care (feeding, dressing) without maximum assistance. If not disabled physically, he may perform motor activities as sitting, reaching and ambulating, but as part of his agitated state and not as a purposeful act or on request necessarily.

V. CONFUSED, INAPPROPRIATE, NON-AGITATED

Patient appears alert and is able to respond to simple commands fairly consistently.

However, with increased complexity of commands or lack of any external structure, responses are non-purposeful, random, or at best fragmented towards any desired goal. He may show agitated behaviour, but not on an internal basis (as in Level IV) but rather as a result of external stimuli, and usually out of proportion to the stimulus. He has gross attention to the environment, but is highly distractible and lacks ability to focus attention to a specific task without frequent redirection back to it. With structure, he may be able to converse on a social-automatic level for short periods of time. Verbalization is often inappropriate; confabulation may be triggered by present events. His memory is severely impaired, with confusion of past and present in his reaction to ongoing activity. Patient lacks initiation of functional tasks and often shows inappropriate use of objects without external direction. He may be able to perform previously learned tasks when structured for him, but is unable to learn new information. He responds best to self, body, comfort and often family members. The patient can usually perform self-care activities with assistance and may accomplish feeding with maximum supervision. Management on the ward is often a problem if the patient is physically mobile, as he may wander off either randomly or with vague intention of “going home”.

VI. CONFUSED-APPROPRIATE

Patient shows goal-directed behaviour, but is dependent on external input for direction.

Response to discomfort is appropriate and he is able to tolerate unpleasant stimuli (such as NG tube) when need is explained. He follows simple directions consistently and shows carry-over for tasks he has relearned (as self-care). He is at least supervised with old learning; unable to be maximally assisted for new learning with little or no carry-over. Responses may be incorrect because of memory problems, but they are appropriate to the situation. They may be delayed and he shows decreased ability to process information with little or no anticipation or prediction of events. Past memories show more depth and detail than recent memory. The patient may show beginning immediate awareness of situation by realizing he does not know an answer. He no longer wanders and is inconsistently orientated to time and place. Selective attention to tasks may be impaired especially with difficult tasks and in unstructured settings, but is now functional for common daily activities (30 minutes with structure). He may show a vague recognition of some staff, has increased awareness of self, family and basic needs (such as food), again in an appropriate manner as in contrast to Level V.

VII. AUTOMATIC-APPROPRIATE

Patient appears appropriate and orientated within hospital and home settings, goes through daily routine automatically, but frequently robot-like, with minimal to absent confusion, but has shallow recall of what he has been doing.

He shows increased awareness of self, body, family, foods, people and interaction in the environment. He has superficial awareness of, but lacks insight into his condition, decreased judgement and problem-solving and lacks realistic plans for his future. He shows carry-over for new learning, but at a decreased rate. He requires at least minimal supervision for learning and for safety purposes. He is independent in self-care activities and supervised in home and community skills for safety. With structure he is able to initiate tasks such as social or recreational activities in which he now has interest. His judgement remains impaired; such that he is unable to drive a car. Pre-vocational or avocational evaluation and counselling may be indicated.

VIII. PURPOSEFUL AND APPROPRIATE

Patient is alert and orientated, is able to recall and integrate past and recent events and is aware of and responsive to his culture.

He shows carry-over for new learning if acceptable to him and his life role, and needs no supervision once activities are learned. Within his physical capabilities, he is independent in home and community skills, including driving. Vocational rehabilitation, to determine ability to return as a contributor to society (perhaps in a new capacity), in indicated. He may continue to show decreased ability, relative to pre-morbid abilities, in abstract reasoning, tolerance for stress, judgement in emergencies or unusual circumstances. His social, emotional and intellectual capacities may continue to be at a decreased level for him, but functional for society.

Acknowledgement: From Hagen, C. et al. (1979). *Rehabilitation of the head injured adult: Comprehensive physical management*, pp. 87–89, by permission of Professional Staff Association Rancho Los Amigos Hospital.

Wessex Head Injury Matrix (WHIM)

Shiel, Wilson, McLellan, Horn, and Watson (2000b)

Source

The WHIM is commercially available from Pearson (http://www.pearson-uk.com).

Purpose

The WHIM is an objective, clinician-administered test, with the aims of (i) monitoring the patient's recovery from the time of coma until emergence from post-traumatic amnesia and (ii) facilitating realistic goal-planning for rehabilitation. It was designed for people with traumatic brain injury (TBI), particularly those described as "slow-to-recover", who experience prolonged periods with reduced levels of consciousness. The WHIM has also been used with other neurological groups, including stroke (Majerus, Van der Linden, & Shiel, 2000).

Item description

The 62-item WHIM is a hierarchically organized test, with items rank-ordered in terms of their sequence of recovery. Three types of behaviours are examined: spontaneous behaviours (e.g., random eye movements), responses to naturally occurring stimuli (e.g., tracks source of a sound), and responses to presentation of standard stimuli (e.g., performs physical movement in response to verbal request). Four broad groups of behaviours within the hierarchy have a demonstrated sequential order of recovery: basic responses are the first group of behaviours to show recovery (e.g., "eyes open briefly"), purposeful actions and beginnings of social interaction appear next (e.g., "makes eye contact" after name is called, "shows selective response to preferred people"), that group is followed by attention and cognitive organization (e.g., "choose an object when requested", "is momentarily distracted by external stimulus but can return to task"), and the final group of behaviours to emerge is orientation and continuous memory (e.g., "can say what part of day it is", "remembers something from the day before"). An example of the item content for the attention and organizing group of items is provided in Table 2.4. Each item is operationally defined.

Table 2.4 WHIM: Items from the attention and cognitive organization group

Item	*Descriptor*
30	Seeks eye contact
31	Monosyllabic or single words in response to questions
32	Looks at, and apparently explores, pictures, magazine, TV, etc.
33	Switches gaze from one person to another, spontaneously
34	Speech is fluent but rambling. Lots of words but meaning hard to discern
35	Looks for object that has been shown and then removed from line of vision
36	Can attend to task, TV, etc., but concentration is vulnerable
37	Monosyllabic or single words to express mood or need
38	Is momentarily distracted by external stimulus but can return to task
39	Can find a specific playing card from a selection of four
40	Smiles
41	Uses writing, typing or other communication aid, but is hard to understand
42	Can say what part of day it is
43	Brief phrases
44	Points with eyes
45	Initiates conversation
46	Vocalizes to attract attention

Acknowledgement: From Shiel, A. et al. (2000a). Wessex Head Injury Matrix (WHIM) main scale: A preliminary report on a scale to assess and monitor recovery after severe head injury. *Clinical Rehabilitation*, *14*(4), 408–416, by permission of Sage Publications Ltd.

Scale development

An early literature review by Horn, Shiel, McLellan, Campbell, Watson, and Wilson (1993) on assessment scales suitable for monitoring recovery during and after coma, heralded work that was being conducted on the WHIM. A detailed description of the developmental process is described in Shiel, Horn, Wilson, Watson, Campbell, and McLellan (2000a). At the outset, the

authors aimed not to make assumptions about either the patterns of recovery or those behaviours that might contribute to it. Instead, they undertook the "laborious task" of determining the actual behaviours occurring during coma. A sample of 88 patients with TBI (age $M = 30$ years, range 14–67; coma duration median = 6 days; duration of PTA median = 30 days) recruited from two hospitals in the UK had daily observations of between 15 minutes and several hours. Additionally, video recordings of up to 24 hours were made in order to sample behaviour throughout the diurnal cycle. A set of "simple stimuli" was also used to elicit behavioural response to stimulation. Almost 150 behaviours that were observed were initially categorized into 10 subscales. The categories were later abandoned, largely because of overlap across a number of subscales. Duplicated items were excluded, resulting in a 58-item scale; some adjustment of item content subsequently occurred, with the final version comprising 62 items. The authors developed operational definitions for each item, the definitions were then reviewed by their larger research team, and thereafter refined in further prospective pilot testing with patients. Date of first emergence of each of the behaviours was recorded and used to calculate the rank order of recovery of behaviours using a paired-preference technique. This item ordering technique is described in detail in Horn, Shiel, McLellan, Campbell, Watson, and Wilson (1993) and Watson, Horn, Wilson, Shiel, and McLellan (1997). The sequence of recovery was largely replicated in an independent sample using a 66-item version of the WHIM (Majerus et al., 2000).

Administration procedures, response format and scoring

The WHIM requires simple test materials comprising everyday items (e.g., a coin, key, playing cards, magazine pictures). The observation period may range from 5 minutes to several hours. Administration starts at Item 1 and continues until the occurrence of 10 consecutive failures. The test manual advises that the WHIM is designed to be used by all qualified members of a multidisciplinary team caring for patients who are in coma. Training of the clinician is required in order to ensure reliable administration. In the reliability studies, the authors developed a 2-hour training session, including video demonstration. Behaviours can be recorded by clinicians either working individually or in pairs, and the latter procedure is recommended for clinicians unfamiliar with the scale.

Responses to items that meet the operational criteria are endorsed. The WHIM score is the rank number of the highest behaviour successfully passed in the 62-item sequence. Shiel et al. (2000a) note that in individual patients the order of recovery of the individual WHIM items is not absolute.

Psychometric properties

Reliability of the WHIM was examined by Shiel et al. (2000a) with an independent sample of 25 patients (age median = 36 years; coma median = 7 days) with TBI recruited from the same hospitals as the sample used for development of the scale. Inter-rater reliability was established with two novice raters who underwent brief training. Another inter-rater reliability study was conducted providing raters with a more detailed, 2-hour training session, including video demonstrations. Validation of the WHIM was reported by Majerus et al. (2000) using a 66-item version of the WHIM in 23 patients (age $M = 50$ years, range 16–75; coma $M = 12.7$ days, range 1–136), mostly with stroke or TBI, recruited from a regional hospital in Liège, Belgium. They were first examined $M = 6$ days (range 0–18) after onset of coma. Reliability was also studied in videotaped behaviours of five patients at various stages of recovery, using two experienced intensive-care nurses who received a 4-hour training package. Test–retest reliability was examined using data from the first session and a second session 1 day later. At 4 years post-trauma, Shiel and Wilson (2005) re-examined 38 of the original 88 patients who had participated in the development of the scale. They identified 14 WHIM behaviours as potential predictor variables and compared the time post-trauma when each behaviour recovered for the subgroup that remained in a minimally conscious state (MCS) at follow-up ($n = 8$) versus those who could participate in testing ($n = 30$). Responsiveness of the WHIM has not been reported in a formal sense, but graphed data from case studies in Shiel et al. (2000b) show marked improvement of scores over time. Results of the foregoing studies are shown in Box 2.7.

Comment

The WHIM is a carefully developed instrument that represents a different approach to measuring recovery of cognitive functioning in patients with an altered level of consciousness. The authors intentionally avoided allocating scores to different levels of response that are then tallied to form either a total and/or subscale scores. Rather, the 62-item scale is rank ordered in terms of the demonstrated sequences of behaviours emerging during coma and its aftermath. Although the authors intended to develop a scale that focused on "what the subject does or does not do, rather than upon clinical diagnostic features" (Sheil et al., 2000a, p. 410), it would be useful to be able to establish when patients have exited from the vegetative and minimally conscious states, particularly

Box 2.7

Validity:	Criterion: *Concurrent:* Majerus et al.: initial WHIM with Glasgow Coma Scale (GCS): $r = .83$ – final WHIM with GCS: $r = .95$ *Predictive:* Shiel & Wilson: 7 WHIM behaviours recovered significantly later in MCS vs non-MCS groups (eyes open, attention held by a dominant stimulus, obeys command to verbal request, watches someone move in line of vision, looks at person giving attention, turns head to look at person talking, focus on person talking)
Reliability:	Inter-rater: Shiel et al. (2000a): novice raters: $k = .25–.84$ – with 2-hour training package: mean $k = .86$ (range $k = .62–1.00$) Majerus et al.: $r_s = .93$; individual items mean $k = .84$ (range $k = -.1–1.00$; grouped results reported as follows: $k \geq .8$ for 73% of items, $k = .4–.73$ for 20%, $k = -.1–.07$ for 7% of items) Test–retest: Shiel et al. (2000a): ~ 2 hour: novice raters: $k = -.66–.12$ – with 2-hour training package: mean $k = .74$ (range $k = .22–1.00$) Majerus et al.: > 1 day: $r_s = .98$
Responsiveness:	No information available

given the conclusions of Majerus et al. (2000) that the WHIM is sensitive to subtle changes in these groups of patients. Considerable efforts have been made to ensure adequate inter-rater reliability of the WHIM, and with the training package the overall reliability is excellent. At the item level, however, a number of items remain poor. A particular strength of the WHIM is the hierarchy of behaviours, which has direct application to individual patient goal-setting and rehabilitation programming.

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Western Neuro Sensory Stimulation Profile (WNSSP)

Ansell, Keenan, and de la Rocha (1989)

Source

The WNSSP is commercially available from Western Neuro Care Center, Tustin, California, USA (http://www.tustinrehab.com).

Purpose

The WNSSP is an objective, clinician-administered test that provides a detailed and standardized assessment of cognitive function in patients with traumatic brain injury (TBI), who are classified on the Rancho Los Amigos Levels of Cognitive Functioning Scale (LCFS) from Level II (generalized, non-purposeful responses) to the early stages of Level V (confused, inappropriate, non-agitated). The WNSSP is designed to evaluate cognitive status, monitor progress and predict improvement in this patient group, which includes patients in the vegetative state (VS) and minimally conscious state (MCS).

Item description

The WNSSP comprises 33 items classified into six subscales: Arousal/attention (4 items), Auditory comprehension (6 items), Visual comprehension (5 items), Visual tracking (7 items), Object manipulation (3 items), and Expressive communication (3 items). An additional 5 items are used to document other responses: auditory response to sound and speech (2 items), olfactory response to smell (1 item), and tactile response to touch (2 items). Each item contains a variable number of levels that are organized hierarchically. For example, in the Arousal/attention subscale the four items address: (i) arousability (4 levels, ranging from a low of "requires repeated presentation of two or more stimuli" to a high of "already awake"), (ii) wakefulness (3 levels, from awake without being re-aroused for "10 minutes or less" to "21 minutes or more"), (iii) eye contact (3 levels, from "eyes closed" to "eyes focused on the examiner 50% or more" of the session), and (iv) attention to task (2 levels, either "attends less than 50% of the time" or "attends 50% or more of the time").

Scale development

Development of the WNSSP was based on "extensive observation of patients' responses to a variety of stimuli" (Ansell et al., 1989, p. 2) which served as a basis for item selection. It was developed within the paradigm of sensory stimulation, such as used at the Rancho Los Amigos Hospital in the 1970s. Response levels for the WNSSP were organized hierarchically, but no information is available regarding the developmental procedures for defining the response levels. Ansell (1993) suggested that a score in the range 65 to 75 indicated that the patient is "rehabilitation ready", although no information was provided about the methods used to derive this range.

Administration procedures, response format and scoring

Stimulus materials (everyday items, such as a comb, teaspoon) are required for administration. The test manual advises the need for a skilled clinician who "must be an astute observer of behaviour" and able to elicit responses in patients with poor responsiveness. Preparation of the raters for the reliability analyses involved them studying and practising administration procedures, discussing scoring discrepancies and conducting 10 administrations (Ansell et al., 1989). Administration time is 20 to 40 minutes. The manual suggests that clinicians spend 15 to 30 minutes prior to assessment observing the patient "at rest" to familiarize themselves with his/her repertoire of behaviours in the natural environment.

Response format for the items varies from dichotomous scoring (1 item from the Arousal/attention subscale) to a 6-point rating scale (e.g., Auditory comprehension). The total score ranges from 0 to 113, with higher scores indicating better levels of functioning.

Psychometric properties

The validation sample comprised 57 consecutive patients with TBI recruited from the Western Neuro

Care Center, Tustin, California, USA (Ansell & Keenan, 1989; Ansell et al., 1989). Average age was 29 years (range 14–72), at an average of 8 months post-trauma (range 1–43), with initial WNSSP assessment occurring within 10 days of admission. Examinations were conducted fortnightly until any of the following occurred: (i) Level V on the LCFS, (ii) scored > 80/113 on the WNSSP on two consecutive test occasions, or (iii) discharge/death. Inter-rater reliability used three raters who simultaneously examined (but independently scored) 23 patients. Examination of predictive validity was reported by Ansell (1993) who examined 116 patients, 55 of whom reached a "rehabilitation ready" criterion (operationalized for that study as WNSSP scores ≥ 72/113) within 2 to 48 months post-trauma. Data on responsiveness are available from Lammi, Smith, Tate, and Taylor (2005) who administered the WNSSP to 18 people in the MCS at rehabilitation admission and at follow-up between 2 and 5 years post-trauma, as well as from Smith, Taylor, Lammi, and Tate (2001) who assessed a subset of 12 patients on four occasions during the course of rehabilitation admission. Results from Ansell et al., except where otherwise stated, are shown in Box 2.8.

Comment

The WNSSP was one of the first published instruments to provide a detailed and objective method to measure small gradations of change in a range of domains of cognition in patients with very low levels of functioning. An increasing number of specialized instruments is available for this purpose, but comparative studies are rare. In a single case study, Canedo, Grix, and Nicoletti (2002) compared five such scales. They were critical of the WNSSP in comparison with other instruments, in part because they found the scoring system difficult to quantify, an issue that has been raised by other investigators (Smith et al., 2001). O'Dell, Jasin, Lyons, Stivers, and Meszaros (1996) also raised concerns about floor effects of the WNSSP in comparison with some other scales. Additionally, the clinical utility of the WNSSP would be enhanced if its scores could be mapped to VS and MCS diagnoses, using established criteria (Giacino et al., 2002).

Box 2.8

Validity:	Criterion: *Concurrent:* with LCFS: $r = .73$ *Predictive:* Ansell: initial WNSSP score was significantly higher for the group that subsequently became "rehabilitation ready" $M = 23.53$ ($SD = 13.15$) vs not "rehabilitation ready" $M = 14.02$ ($SD = 10.83$); $t = -4.28$, $p < .001$ – logistic regression analysis: visual tracking predicted "rehabilitation ready" status; auditory comprehension predicted speed of improvement Construct: *Internal consistency:* Cronbach alpha: .95 (subscale range .35 – .94; with < .8 for 2/6 subscales – arousal/attention, expressive communication) *Disciminant:* LCFS Level II $M = 11.28$ ($SD = 7.39$) vs Level III $M = 40.32$ ($SD = 15.50$); $p < .05$ – Level IV $M = 50.78$ ($SD = 28.37$) vs Level V $M = 85.09$ ($SD = 24.77$); $p < .05$
Reliability:	Inter-rater: Mean $k = .70$ (item range $k = .43 - .96$; with $k > .6$ for 23/33 items) Test–retest: No information available
Responsiveness:	Lammi et al.: Initial WNSSP $M = 35.56$ ($SD = 22.43$) vs 2–5 year follow-up $M = 101.67$ ($SD = 23.88$); $d = 2.95$ Smith et al.: Initial WNSSP $M = 28.25$ ($SD = 26.66$) vs Time 4 $M = 41.47$ ($SD = 27.20$); $d = 0.50$

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SECTION 2
Scales measuring delirium

Cognitive Test for Delirium (CTD)

Hart, Levenson, Sessler, Best, Schwartz, and Rutherford (1996)

Source

Items for the CTD and the recording form can be found in the Appendix to Hart et al. (1996). An abbreviated version of the CTD has also been published (Hart, Best, Sessler, & Levenson, 1997).

Purpose

The CTD is an objective, clinician-administered test developed to identify patients in an intensive care setting with delirium. Most, though not all, will be older adults hospitalized for medical problems. The CTD has also been used with younger people with traumatic brain injury (TBI; Kennedy, Nakase-Thompson, Nick, & Sherer, 2003; Nakase-Thompson, Sherer, Yablon, Nick, & Trzepacz, 2004). A special feature of its design allows responses to be made exclusively in the non-verbal mode.

Item description

Five cognitive domains are sampled in the CTD, which also incorporates some items from other commercially available cognitive tests: Orientation (3 items: month, time of day, name of place), Attention (2 items: forward and backward visual memory span), Incidental and recognition memory (2 items: recall of 5 pictures), Comprehension (6 items: 4 items requiring yes/no response, e.g., "Will a stone float on water?"; 2 items identifying the odd item from a set of 4 items, e.g., "arm, house, foot, nose") and Vigilance (2 items: auditory cancellation task). Two alternate forms are available for the memory, comprehension and vigilance items. The abbreviated version of the CTD examines two domains: Visual attention span and Memory (picture recognition).

Scale development

Item development drew on existing instruments, but limited information is provided on the rationale for selection of the specific scales. Items drawn or adapted from other standardized cognitive tests include the Visual Memory Span subtest from the Wechsler Memory Scale – Revised (WMS-R) for attention, and the Auditory Comprehension, Part D, Complex Ideational Material from the Boston Diagnostic Aphasia Examination for comprehension. These instruments, which are commercially available, are described in Lezak, Howieson, and Loring (2004). Other items for the Orientation, Vigilance and Memory subtests are commonly found in cognitive screening tests. Receiver operating characteristic (ROC) curves were used to derive a cut-off score. Stepwise discriminant analysis conducted on data from the original validation sample was used to derive an abbreviated CTD (Hart et al., 1997). The visual attention span and picture recognition memory items were discriminating and able to differentiate among four clinical groups, including a delirium group. ROC analysis indicated that the most discriminating cut-off score for the abbreviated version was 10/11 (95% sensitivity; 99% specificity). The abbreviated version correlated highly with the full version ($r = .91$).

Administration procedures, response format and scoring

Test materials required for administration include the sets of pictures (available in the Appendix to Hart et al., 1996) and the Visual Memory Span materials from the WMS-R. The examiner needs to construct stimulus materials for the multiple choice orientation items, anchored to the current date. Visual stimuli are enlarged (1.5 cm high for print and 3.5 cm for pictures). Instructions for administration are incorporated into the recording form. In the validation study the CTD was administered by a psychologist trained in test administration procedures. Administration time is 10 to 15 minutes, but the abbreviated version requires only a few minutes.

A unique feature of the CTD is the response format, which was developed to take account of the special

needs of people in intensive care, who may be intubated, functionally illiterate or have restricted movement. All responses can be made in the non-verbal mode, using pointing for multiple choice responses (orientation and memory items), head movement to indicate yes/no response (comprehension items), and hand movement (attention and vigilance items).

Responses to the CTD are scored for accuracy, usually 1 point for each correct response. Raw scores for each subtest are then converted, using formulae described in the scoring procedures. For this purpose, the recording and scoring forms have a good format and are easy to follow. The resulting score range is 0 to 6 for each subtest. The total score ranges from 0 to 30, with higher scores indicating better performance. Scores can also be used to diagnose delirium, using a cut-off score of 18/19.

Psychometric properties

Reliability and validity of the CTD were examined in 103 patients in four clinical groups: delirium ($n = 22$), dementia ($n = 26$), depression ($n = 30$) and schizophrenia ($n = 25$) recruited from Medical College of Virginia Hospitals, Richmond, Virginia, USA (Hart et al., 1996). Equivalence of the two alternate forms was examined in the dementia sample, using a counterbalanced order of administration. There were no differences between the parallel forms or administration order and the two forms were very highly inter-correlated (ICC = .90). For the validation study, criteria from the *Diagnostic and Statistical Manual for Mental Disorders* 3rd ed. – Revised (DSM-III-R) were used to diagnose delirium, which was made by a psychiatrist after a clinical interview, mental status examination and medical record review. Other validation instruments were the Mini-Mental State Examination (MMSE) and the Mattis Dementia Rating Scale (MDRS). The cut-off score of 18/19, identified by ROC analyses, yielded 100% sensitivity and 95% specificity in differentiating delirium from other conditions. The authors noted that although the CTD did not reliably distinguish delirium from severe dementia, the latter is commonly accompanied by a degree of confusion. Data on responsiveness are available from the case series of Mittal et al. (2004) who treated 10 patients with risperidone.

In its application to the TBI group, Kennedy et al. (2003) analysed ROC curves and recommended a higher cut-off score (21/22) for optimal diagnosis (sensitivity 71%, specificity 72%). In this clinical group, the lower cut-off score recommended for the CTD (18/19) increased specificity (75%), but at the cost of sensitivity (62%). They also examined the underlying factor structure using principal components analysis. A single factor was extracted, accounting for 79% of the variance, suggesting that the CTD was unidimensional. Nakase-Thompson et al. (2004) examined 85 patients admitted for rehabilitation after TBI, 69% of whom met DSM-IV criteria for delirium. Results from Hart et al. (1996), unless otherwise stated, are shown in Box 2.9.

Box 2.9

Validity:	Criterion: *Concurrent:* Delirium group: with MMSE: $r = .82$ Dementia group: with MMSE: $r = .81$ – with MDRS: $r = .76$ Construct: *Internal consistency:* Cronbach alpha: Delirium group: .87 *Factor analysis:* Kennedy et al.: a single factor *Discriminant:* Delirium group $M = 9.5$ ($SD = 5.0$) vs dementia $M = 24.5$ ($SD = 1.9$), depression $M = 28.8$ ($SD = 1.9$), schizophrenia $M = 27.9$ ($SD = 2.2$); $p < .05$ – Differential diagnosis between delirium vs other conditions using cut-off score 18/19: sensitivity 100%, specificity 95% Nakase-Thompson et al.: patients in delirium median = 11 vs patients not in delirium median = 28; $p < .001$ Kennedy et al.: Differential diagnosis between delirium vs no delirium in patients with TBI using cut-off score 21/22: sensitivity 71%, specificity 72%
Reliability:	Inter-rater: No information available Test–retest: No information available
Responsiveness:	Mittal et al.: significant improvement with risperidone: Day 1 $M = 7.1$ ($SD = 2.0$) vs Day 6 $M = 16.9$ ($SD = 3.0$); $p < .01$, $d = 4.9$

Comment

Although a number of symptom rating scales for delirium are available, one of the strengths of the CTD is that it makes an objective evaluation of cognitive symptoms, using a standardized set of items, with alter-

nate forms and empirical data to support cut-off scores. Another advantage is the response format in the non-verbal mode, allowing administration to patients with speech limitations. The CTD does, however, require the patient's active cooperation. In their study of advanced cancer patients using a different delirium measure, Lawlor, Nekolaichuk, Gagnon, Mancini, Pereira, and Bruera (2000) found that 21% were unable to participate in initial testing. They thus recommended the need for instruments that are "at least partially observational" in this population. Moreover, although the CTD provides a good evaluation of the cognitive symptomatology of delirium, in isolation it has limitations as a delirium measure because it does not consider other cardinal symptoms necessary for a diagnosis of delirium, such as sudden onset with fluctuating course. Thus it may have wider application as a more general cognitive screening test.

Key references

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Confusion Assessment Method (CAM)

Inouye, van Dyck, Alessi, Balkin, Siegal, and Horwitz (1990)

Source

Description of the CAM and supporting interview procedures, along with operational definitions of the four CAM diagnostic features and scoring algorithm, are available in appendices in Inouye et al. (1990), and are reproduced below. A derivative of the CAM, CAM-ICU (Ely et al., 2001) is also briefly described below.

Purpose

The CAM is a clinician rating scale that uses information from patient history, clinical observations and objective cognitive tests to diagnose delirium in older adults. It was developed in order to provide a quick, accurate and standardized method that could be used by non-psychiatrists.

Item description

The CAM is a nine-item scale addressing specific clinical features commonly observed in delirium. The nine items are as follows (with the four items used in the algorithm to diagnose delirium asterisked): acute onset and fluctuating course*, inattention*, disorganized thinking*, altered level of consciousness*, disorientation, memory impairment, perceptual disturbance, psychomotor activity (psychomotor agitation, psychomotor retardation), and sleep–wake cycle.

Scale development

Development of the CAM, described in Inouye et al. (1990), drew on criteria from the *Diagnostic and Statistical Manual of Mental Disorders* – 3rd ed. – Revised (DSM-III-R). Important clinical features indicative of delirium were identified and defined using non-technical language. A literature review and expert panel were used to identify diagnostically important clinical features. The algorithm was developed using the expert panel, who recommended that the last five of the nine items not be included because of their lack of specificity to delirium.

Administration procedures, response format and scoring

Test materials are required for the patient assessment component of the CAM (Mini-Mental State Examination, MMSE, described in Chapter 3; and Digit Span, DS). The CAM is completed by the clinician following informant interview, patient assessment and chart review. The authors advise that some training is required for optimal use of the CAM. Following collection of the necessary background information, completion time for the CAM record form itself is less than 5 minutes.

Items are endorsed if they are present, or the response that best represents the patient's presentation is selected. The following algorithm for diagnosing delirium is used: *both* feature 1 (acute onset and fluctuating course) *and* feature 2 (inattention) are present, as well as *either* feature 3 (disorganized thinking) *or* feature 4 (altered level of consciousness).

Psychometric properties

An expert panel completed a detailed, standardized critique of the extent to which the CAM addressed general concepts and specific features of delirium, as well as the utility of the algorithm. The CAM was regarded as having high face validity, although concern was expressed regarding the diagnostic specificity in distinguishing between dementia and delirium. Measurement properties of the CAM were examined by Inouye et al. (1990) in studies at a number of sites in the USA, using two samples of elderly hospitalized patients ($n = 30$ and $n = 26$; age range 65–98 years). Patients were a mixed group; some had diagnoses of suspected delirium, confusion, dementia, depression; others had normal mental status; others were observed by nurses to exhibit abnormal thinking or behaviour. Inter-rater reliability used data from 10 patients and validating instruments comprised the MMSE, story recall, DS, and the Visual Analogue Scale for Confusion (VASC). Diagnostic accuracy against psychiatrist diagnosis using DSM-IV criteria yielded 100% sensitivity and 95% specificity.