Intensive Care Med (2004) 30:1997–2008
DOI 10.1007/s00134-004-2418-y

REVIEW

Sharon M. Gordon
James C. Jackson
E. Wesley Ely
Candace Burger
Ramona O. Hopkins

Clinical identification of cognitive impairment in ICU survivors: insights for intensivists

Received: 19 February 2004
Accepted: 26 July 2004
Published online: 2 October 2004

S. M. Gordon · J. C. Jackson (✉) · E. W. Ely
Center for Health Services Research, Vanderbilt University, 6100 Medical Center East, Nashville, TN 37232, USA
e-mail: james.c.jackson@vanderbilt.edu
Tel.: +1-615-9362822

S. M. Gordon · C. Burger
Department of Psychiatry, Vanderbilt University School of Medicine, Nashville, TN 37232, USA

S. M. Gordon · E. W. Ely
VA Tennessee Valley Geriatric, Education and Clinical Center, Nashville, Tenn., USA

J. C. Jackson · E. W. Ely
Division of Allergy/Pulmonary/Critical Care Medicine, Vanderbilt University School of Medicine, Nashville, TN 37232, USA

R. O. Hopkins
Psychology Department and Neuroscience Center, Brigham Young University, Provo, Utah, USA

R. O. Hopkins
Department of Medicine, Pulmonary and Critical Care Divisions, LDS Hospital, Salt Lake City, Utah, USA

Abstract *Background:* A growing body of research has demonstrated the presence of ongoing cognitive impairment in large numbers of ICU survivors. *Objective:* This review offers a practical framework for practicing intensivists and those following patients after their ICU stay for the identification of cognitive impairment in ICU survivors. *Conclusions:* Early detection of cognitive impairment in critically ill patients is an important and achievable goal, but overt cognitive impairment remains unrecognized in most cases. However, it can be identified by objective (test scores) or subjective evidence (clinical judgment, patient observation, family interaction).

Keywords Cognitive impairment · Neuropsychological assessment · Encephalopathy · Geriatrics · Critical illness · Intensive care unit

Recent communication from an ICU survivor

The following are selected comments from a 40-year-old college-educated ICU survivor (acute respiratory distress syndrome) writing to her internist (E.W.E.) 2 years after her discharge:

> I hate to be a bother, but I have some questions about the problems that I am having. Since you cared for me in the ICU, I have been out of the hospital and trying to get on with my life for the past 2 years. Primarily, how long my memory will be effected? I am having daily problems with many different things. I have trouble with people's names that I have worked with for years. I can't remember where I put things at home. I can't help my children with their homework because I don't remember how to do simple multiplication problems. It is so embarrassing that I cant balance my check book

and keep having these bounced checks. Goodness, I am a college graduate! This is really effecting my day to day life. Is there any way I can find out to what extint this will effect my memory and for how long? I just want to know what to expect and is there any way for me to improve my situation? Please contact me with any information regarding my condition.

Introduction

Approximately 55,000 patients are hospitalized in intensive care units (ICUs) each day in the United States [1]. While research is limited regarding cognitive outcomes in patients who survive critical illness, these patients are at risk for physical, emotional, and neurocognitive morbidity [2, 3, 4, 5, 6]. Although additional research is necessary to address crucial questions regarding cognitive impairment in ICU survivors, early reports are worrying, and in some respects parallel early reports of cognitive impairment following coronary artery bypass grafting (CABG). Two decades ago studies on CABG and cognitive outcome were in their infancy and received relatively little attention [7]. Since that time over 50 investigations [8] have studied the effects of CABG on cognition and have documented the existence of pervasive and frequently severe cognitive deficits in 20–80% of patients following surgery [9]. The cognitive impairment reported in ICU survivors is similar to that observed following elective CABG surgery [10] and following carbon monoxide poisoning [11].

Current data suggest that approximately one-third or more of ICU survivors develop ongoing and persistent cognitive impairment [6]. Among specific populations of ICU survivors such as patients with acute respiratory distress syndrome (ARDS) the prevalence of persistent cognitive impairment is even greater and may be as high as 78% at 1 year [12] and 25% at 6 years [13] (Table 1). While cross-study comparisons are difficult due to differences in study design (e.g., prospective vs. retrospective), definition of sequelae, neurocognitive tests administered, time to follow-up, patient population, and disease severity, the potential ramifications of these findings are significant, particularly if cognitive impairment goes unidentified. The purpose of this report is to highlight the problem of cognitive impairment following ICU survival, to assist clinicians in identifying probable cognitive impairment in ICU patients through objective as well as clinically oriented strategies, and to provide guidelines for referral of cognitively impaired patients to specialists in cognitive evaluation and rehabilitation. For a discussion of research issues with ICU survivors, please refer to our companion article in this issue.

Importance of cognitive impairment

Defining cognitive impairment

This review uses key terms that are widely understood in psychiatric, neurology, and neuropsychological settings but may be less familiar to intensivists. The term cognitive impairment, as defined here, refers to *clinically significant abnormalities* in one or more brain functions including memory, attention, mental processing speed, executive function, visual spatial abilities, and intellectual function. Cognitive impairment can be mild, moderate, or severe and can limit an individual's ability to think, reason, and/or perform everyday tasks. The term cognitive decline refers to deterioration in cognitive abilities from baseline and is not necessarily synonymous with cognitive impairment as it does not imply an absolute level of functioning. For example, a person with an intelligence quotient in the superior range might experience significant cognitive decline and still function within the normal range, therefore not being characterized as cognitively impaired. However, this type of decline can cause significant disruption in the everyday life of a person who is used to performing at high levels in occupational and vocational areas. Such was the case of the person quoted in the opening paragraph. Alternatively, slight decline in a person with below average intelligence could result in the diagnosis of cognitive impairment but have a minor impact on everyday function.

The impairment experienced by patients following ICU hospitalization should not be equated with common dementias, such as Alzheimer's disease and vascular dementia, which are typically age related, largely irreversible, progressive in nature, and characterized by significant impairments in memory and at least one other sphere of mental activity [14, 15]. In contrast to common dementias, there is only limited information regarding the clinical course of ICU-related cognitive impairment. For example, cognitive functioning appears to improve in many ICU survivors from hospital discharge to 1 year; however, significant numbers (46%) of ICU survivors remain impaired at 1 year [12], with little improvement during the 2nd [16].

Severity of acquired deficits

The cognitive impairment experienced by many ICU survivors varies widely with regard to severity and should be thought of as acquired disease or an exacerbation of a preexisting disease (depending upon the individual patient's situation). Acquired cognitive impairment can range from mild to severe. For example, Jackson et al. [6] reported that after excluding those with detectable pre-ICU baseline cognitive impairment 34% of patients suffered from persistent cognitive impairment of a *severity*

Table 1 Summary of studies on cognitive outcomes following critical illness

Reference	Population	Age (years)	Test Interval	No. of tests	Comments
Jackson et al. [6]	34 ICU survivors	53.2±15.3	6 months after hospital discharge	9	30% of patients experienced generalized cognitive decline at 1 year on at least one of the following: memory, attention/concentration, processing speed
Rothenhausler et al. [13]	46 ARDS survivors	41.5±14.7	Median 6 years after ICU discharge	1 with 9 subtests	24% of patients displayed moderate/severe cognitive impairment in attention and memory, 100% of whom were disabled (unable to work)
Hopkins et al. [12]	55 ARDS survivors	45.5±16.0	12 months after hospital discharge	6 with multiple subtests	32% of patients were cognitively impaired to a degree consistent with at least mild dementia
Abstracts					
Al-Saidi et al. [61]	87 ARDS survivors	Median 44	12 months after hospital discharge	1	20% rated memory as poor, 38% reported severe depression
Hopkins et al. [85]	67 ARDS survivors	45.9±16.4	Hospital discharge, 12 and 24 months after hospital discharge	6 (3 with multiple subtests)	Impaired in general intelligence, memory, attention/ concentration, processing speed or executive function at 1 and 2 years; significant improvement in cognitive function in 1 year; little additional improvement from 1 to 2 years
Marquis et al. [86]	33 ARDS survivors and 23 critically ill controls	NA	At least 1 year after ARDS	NA	Cognitive impairments in attention, visual processing, psychomotor speed, and cognitive flexibility (more prevalent in ARDS survivors than controls)
Case reports					
Jackson et al. [87]	1 ARDS survivor	49	7 months after hospital discharge	9	Impairment in attention, executive dysfunction, and visual memory; decline of +2 SD from baseline on measures of verbal, performance, and full-scale IQ
Hopkins et al. [88]	2 Hanta virus survivors	56/67	12 months after hospital discharge	7 (3 with multiple subtests)	Impaired attention, memory, mental processing speed, and mild generalized cognitive decline

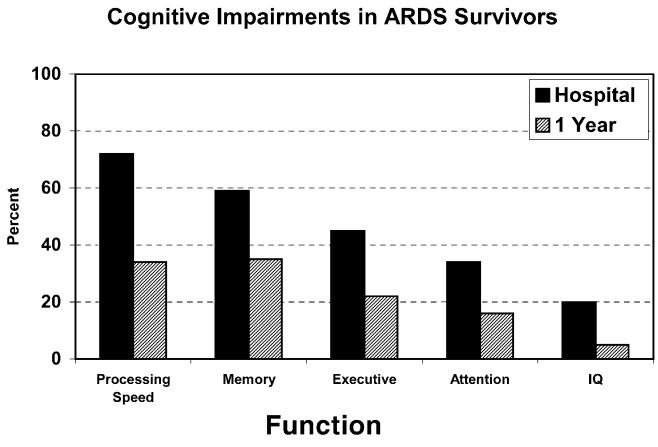

Fig. 1 Proportion of survivors of acute respiratory distress syndrome with cognitive impairments by cognitive domain at hospital discharge and 1 year postdischarge. (Data from [12])

similar to the cognitive impairments observed in mild to moderate dementia. Although the nature of deficits differs across studies, it appears that impairment is particularly pervasive in areas of memory, visuoconstruction, processing speed, and executive functioning (Fig. 1). The cause and risk factors for the development of cognitive impairment following ICU hospitalization are largely unknown, although the risk factors for cognitive impairment following cardiac surgery are well documented and include advanced age, lower premorbid intelligence, cerebrovascular and peripheral-vascular disease, and hypoxia [17, 18]. Researchers have hypothesized that the presence of certain factors such as sepsis and ARDS and its associated hypoxemia [12], the development of delirium [19], and the use of sedative and narcotic medications are associated with the development of cognitive impairment after critical illness, although such mechanisms are in need of further exploration.

Functional and financial implications of cognitive impairment for ICU survivors

Although between one and three of every four patients experience cognitive impairment following ICU treatment [6, 12], little is known regarding the functional and financial impact of such impairment in these patients. Cognitive impairment is generally associated with inability to return to work, decreased quality of life and independence, and generalized functional decline; an important caveat to this observation, however, is that many investigations on the consequences of cognitive impairment have been carried out in populations with Alzheimer's disease, and may not be directly applicable to ICU survivors [20, 21, 22, 23]. Cognitive impairment resulting from a host of illnesses and medical syndromes including human immunodeficiency virus, ARDS, traumatic brain injury, and bacterial meningitis are associated with decreased quality of life [13, 24, 25, 26]. Even mild forms of cognitive impairment can be extremely problematic and may lead to significant difficulties in activities of daily living such as impaired driving, money management, and performance of basic household functions (e.g., cleaning, cooking, organizing) [27, 28, 29].

The specific economic consequences of cognitive impairment following a stay in the ICU are not yet known. However, in the general population the economic consequences of cognitive impairment are substantial and depend on factors such as the severity and nature of impairment, rate of decline, and the setting in which care is provided (e.g., nursing home vs. private residence) [30]. For example, a 3-point decrease on the Mini Mental State Examination (MMSE) is associated with a $6,000 per year increase in overall healthcare expenditures [31]. The "per-patient societal cost burden" of even mild forms of cognitive impairment is estimated to be over $15,000 per year [32]. The costs associated with traumatic brain injury are less well known, but it appears that the wages of individuals returning to work after a brain injury decline by approximately 50% per year [33].

Should the ICU team strive towards early identification of cognitive impairment?

A consensus is emerging among neurologists, psychiatrists, and other specialists regarding the importance of early identification of cognitive impairment [34]. The failure to identify cognitive impairment can have serious implications for patients in a variety of functional domains. For example, a person may return to work based on the erroneous assumption that he or she is "perfectly fine," only for the patient to encounter difficulties performing at the previous level due to problems with memory and disorganization. These difficulties may be wrongly attributed to "laziness" or lack of motivation and may result in the termination of employment. Situations such as this are not inevitable and can often be avoided if a patient's cognitive impairment is identified as such. The identification of cognitive impairment is valuable not only to patients but also to their families and caregivers as it enables them to mobilize necessary resources before the onset of a crisis such as inability to care for self or children and to function independently.

The lack of early identification of cognitive impairment delays referral for cognitive rehabilitation, which has been shown to improve cognitive function [35]. Cognitive rehabilitation may be appropriate for individuals with cognitive impairment due to a wide variety of causes (e.g., traumatic brain injury, cerebrovascular accident, hypoxia) and is considered to be effective in improving neuropsychological abilities such as attention/concentration, memory, and executive function [36].

Despite the importance of early identification of cognitive impairment, studies consistently demonstrate that physicians fail to recognize (or assess) cognitive impairment in 35–90% of patients in non-ICU clinical practice settings [37, 38]. Recent data suggest that cognitive impairment is rarely evaluated in ICU patients [6] and may be overlooked in one of every two cases [39]. Reasons for limited recognition of cognitive impairment include time constraints, perception of limited treatment options, and limited knowledge regarding how to perform cognitive screening [40]. Intensivists and those caring for patients after the ICU stay should be aware that there are excellent brief screening tools that can be readily used in the midst of a busy day by themselves or other members of the ICU team (Table 2). These measures are simple to use and do not require specialized training to administer. While the early identification of cognitive impairment is very important, the approaches to identification vary widely depending on the setting.

Clinical issues in the identification of cognitive impairment

Assessing patients in various hospital and outpatient settings presents various challenges and may require the use of different tools. Patients can be assessed at various stages of their illness as they move from the ICU to acute care and then to the outpatient setting. Cognitive impairment in these different settings can be identified in a variety of ways and can be based on objective data (e.g., test scores) or more subjective evidence (e.g., clinical judgment, patient observation, family interaction). The following section suggests a logical approach at each stage and consider advantages and limitations of tools that can be used in each setting.

How do you identify cognitive impairment in critically ill ICU patients?

In many instances intensivists are the providers best positioned to identify possible acute cognitive impairment in critically ill patients. Although it is unlikely that they have the time to assess these patients individually, evaluations can be performed by nurses and other allied healthcare professionals such as psychologists, social workers, and speech therapists [41, 42]. However, due to multiple factors in ICU settings such as mechanical ventilation, related communication difficulties, the high prevalence of delirium, and patient fatigue, formal in-depth assessment of critically ill patients is often not possible. Sometimes the only assessment possible in such populations is related to detection of delirium, which can be rapidly and reliably assessed with the Intensive Care Delirium Screening Checklist [43, 44] or the Confusion Assessment Method for the Intensive Care Unit (CAM-ICU) [45, 46]. For free downloads of material used to monitor delirium in the ICU (including translations into multiple languages) the reader is referred to the educational website: http://www.icudelirium.org. If patients are not delirious, their cognitive function can be quickly evaluated using the MMSE or another brief cognitive screening tool. The detection of delirium may be important in light of evidence suggesting an association between delirium and an increased risk of cognitive impairment and other adverse outcomes (although much remains to be discovered about this association) [19].

How do you identify cognitive impairment following ICU stay in hospitalized patients?

When patients are discharged from the ICU to rehabilitation or general hospital units, their cognitive status may improve, and they may be more able to interact with an evaluator or clinician. At this point neuropsychological assessment may be appropriate and the completion of such testing more realistic. In cases where cognitive screening is possible numerous suitable instruments are available [47]. The MMSE is widely considered the "gold standard" among screening tools and consists of 17 items (30 possible points) that assess a range of global abilities including orientation, memory, and attention [48]. A score of 23 or below on the MMSE indicates the presence of moderate to severe cognitive impairment, but it should be noted that the test is susceptible to the effects of age and education and can be more reliably scored using age and education adjusted norms [49]. Other screening tools that are equally "user friendly" and, in some cases require even less time to administer are available (Table 2). In general, cognitive screening instruments require little if any specialized training to administer and score, and depending on the instrument the administration time varies from 1 to 10 min. While the sensitivity and specificity of these instruments vary, they generally have acceptable reliability and validity and are effective at identifying moderate to severe cognitive impairment. They are less sensitive in the detection of mild forms of cognitive impairment [47]. While more comprehensive and sophisticated instruments exist, using them with hospitalized patients may be impractical as they can be quite lengthy and may require specialized training to administer.

Moderate or severe forms of cognitive impairment can frequently be identified without the use of psychometric instruments or questionnaires and through reliance on more subjective methods [50, 51, 52]. These methods include the use of clinical judgment, the direct observation of patients, and interaction with families. The perceptions of family members can be very helpful as parents, spouses, or children are often aware of even minor changes in a patient's functional abilities or personality.

Table 2 Brief cognitive screening tools (<10 min) for cognitive impairment

Test	Admin. time	Description	Cutoff score	Comment (pro/con)
Clock Drawing Test [89]	1 min	A test requiring subjects to draw a clock face that reads a specific time suggested by the examiner	Varies widely depending on scoring system	Pro: assesses broad range of cognitive abilities and can be used by individuals with little experience in assessment Con: can be difficult to score and is adversely effected by advanced age and low education
Mini-Cog [90]	3 min	A recall test of three unrelated words and includes a Clock Drawing Test	Impairment defined asinability to recall 3/3 words or abnormal clock	Pro: not effected by language or education and can detect mild cognitive impairment Con: measures only two cognitive domains
Time and Change Test [91]	3 min	A timed test requiring subjects to tell time from a clock and to assemble a dollar in change (from a group of coins placed in front of them)	An incorrect response on either/or both tasks suggests probable dementia	Pro: very brief and simple to administer Con: poor sensitivity and specificity
Memory Impairment Screen [92]	4 min	A memory test consisting of four items including delayed, free, and cued recall	A score of <5 indicates probable cognitive impairment	Pro: discriminates between vascular dementia and Alzheimer's dementia Con: tests only one cognitive domain (memory)
General Practitioner Assessment of Cognition [93]	5 min	A test with cognitive questions (nine items) and informant data (six items) in order to increase predictive power	Client must score between 5 and 8 on part 1 and less than 3 on part 2 to be diagnosed with probable dementia	Pro: high sensitivity in detecting mild cognitive impairment Con: utilizes a complicated scoring system
Mini-Mental State E xam [48]	7–10 min	A 17-item tool that assesses orientation, registration, short-term memory, attention, calculation, visuoconstruction, and praxis	A score of <24 indicates probable dementia	Pro: easy to score and considered the most familiar screening tool Con: scores effected by age, education, and literacy levels (requires age/education adjusted norms)
Telephone Interview for Cognitive Status [94]	7–10 min	A telephone screening instrument that assesses global cognitive function	33–41 nonimpaired; 26–32 ambiguous; 21–25 mild impairment; <20 moderate to severe impairment	Pro: clinical utility (allows patients to be assessed remotely) Con: no direct observation involved, limited range of domains assessed

Table 3 A selective list of functional (IADL) assessment questionnaires

Test	Reference	Description	Admin. time	No. of items	Cutoff score	Comment
Functional Activities Quesitonnaire IADL	Pfeffer et al. [55]	Informant based measure of high-order functional abilities	5 min	10	Score greater than 9 suggests the presence of dementia	Pro: effective at distinguishing between dementia and normal aging Con: scores are based on the perceptions of an informant and may be inaccurate
Lawton's IADL	Lawton [56]	Widely used measure of IADLs validated for use in elderly populations	5 min	8	Positive scores on four items (telephone use, transportation, medication management, and handling finances) correlated with diagnosis of dementia	Pro: validated for use in elderly populations Con: research on using Lawton's IADL as a dementia screening tool is equivocal

The following is a list of warning signals, or "red flags," that can suggest possible cognitive impairment in hospitalized or ICU patients:

- Personality changes
  - Increased apathy
  - Loss of social inhibitions, display of socially inappropriate behavior with staff
  - Increased irritability or suspiciousness toward family, visitors, or medical team
  - Outbursts of inappropriate or unprovoked anger
- Memory complaints
  - Difficulty learning new facts and information about one's medical condition
  - Persistent word finding problems
  - Inability to recall conversations with medical staff and recent events in the hospital such as visits by staff, family, or friends
  - Inability to remember having eaten or what was eaten at meal time
- Executive dysfunction
  - Difficulty following nurses', physicians', or therapists' directions
  - Problems with planning and decision making related to such things as discharge planning
  - Confusion when trying to perform multiple tasks
- Functional deficits
  - Difficulty looking up telephone numbers or using the telephone or other equipment such as the television and hospital bed
  - Decline in self-care not attributable to physical problems or limitations
  - Inability to find one's room
  - Inability to follow a conversation
  - Difficulty following through with tasks

Caution should be exercised when drawing conclusions about cognitive functioning based on in-hospital assessments as performance may be adversely affected by factors such as fatigue and residual effects of sedative and narcotic medications.

How do you identify cognitive impairment following ICU stay in the outpatient clinic?

Patients typically return to outpatient clinics approx. 1–2 months after hospital discharge for routine follow-up. By then patients have recovered from any transient cognitive dysfunction (e.g., delirium, effects of medications) and may be functioning at levels that reflect their new baseline. Generally, individuals have begun to resume their normal activities and may experience previously nonexistent functional limitations due to acquired cognitive impairment. It may be beneficial to repeat the MMSE and compare the current score with those obtained during the patient's hospitalization. Improvement in cognitive function is expected and a decline of more than 3 points (or a score below the standard cutoff of 23), as well as the presence of persistently abnormal scores, suggests the need for further evaluation, as the MMSE is a relatively stable, reliable measure and resistant to large fluctuations in scoring in the absence of actual neuropsychological change [53].

It is also appropriate to assess activities of daily living such as bathing and dressing or, more importantly, instrumental activities of daily living (IADLs) such as cooking, following a recipe, and balancing a checkbook (which can be significantly affected by even minor neuropsychological changes) [27, 54]. Formal assessments of functional abilities can be carried out with instruments such as the Pfeffer et al. [55] Functional Activities Questionnaire (FAQ) and the Lawton and Brody [56] Instrumental Activities of Daily Living (Table 3) or by asking simple, targeted questions. For example, clinicians can inquire about a patient's ability to perform complex

Table 4 Common screening tools for psychological disorders

Test	Reference	Admin. time	No. of items	Cutoff score	Comment
Anxiety					
Beck Anxiety Inventory	Beck et al. [76]	5–10 min	21	0–7 mimimal anxiety; 8–15 mild anxiety; 16–25 moderate anxiety; 26–63 severe anxiety	Four-point rating scale of anxiety symptoms
Hospital Anxiety and Depression Scale	Zigmond et al. [75]		7	8–10 borderline anxiety; ≥11 definite anxiety	Widely used with medical patients
Depression					
Beck Depression Inventory	Beck [73]	5–10 min	21	0–9 minimal depression; 10–16 mild depression; 17–29 moderate depression; >30 severe depression	Multiple choice format makes it more difficult for elderly patients to respond
Geriatric Depression Scale-SF	Sheik and Yesavage [72]	5 min	15	>5 Depression	Assesses cognitive dimensions of depression while minimizing the somatic components of depression
Center for Epidemiologic Studies Depression Scale	Radloff [74]	5–10 min	20	>16 Clinical depression	Primarily assesses cognitive and affective dimensions of depression

tasks such as using a telephone or a remote control, following a complex recipe, making a grocery list, or managing money or medications [57]. An important factor to evaluate is the presence of change and the degree to which the current level of function is different from prehospital levels. Poor performance on measures of functional ability are not proof of cognitive impairment but can assist a practitioner in determining whether a patient should be referred for a more comprehensive neuropsychological assessment [58].

Depression and other psychological problems

Many ICU survivors experience significant affective symptoms such as depression and anxiety [59]. The prevalence and severity of affective disorders including symptoms of depression and anxiety in ICU survivors range from less than 10% to 58% [6, 12, 60, 61, 62]. Depression has been reported to occur in up to 30% of ICU survivors [6], and it is estimated that 47% have clinically significant anxiety [59]. Indeed, it may be that the high rates of depression among ICU survivors are related to the cognitive impairment they experience, although this has not been evaluated in ICU cohorts. Affective disorders such as depression as well as posttraumatic stress disorder and anxiety may adversely affect test performance, especially if severe [63, 64]. Moderate to severe depression may result in decreased effort and low motivation that may decrease neuropsychological test scores in cognitive domains such as psychomotor speed or attention [65, 66], whereas moderate to severe anxiety may result in increased distractibility and blocked thoughts or words [67, 68]. In some cases severe depression may mimic symptoms of cognitive impairment, although important differences exist between these conditions. In general, individuals with depression retain the ability to learn and do not forget as rapidly, do not display significant decrements in language, are inconsistent with regard to orientation to time and date and are typically more self-aware than their cognitively impaired counterparts [69, 70, 71].

A variety of instruments are available for use in the assessment of affective function (Table 4). Those for assessing depression include the Geriatric Depression Scale–Short Form (GDS-SF) [72], the Beck Depression Inventory (BDI) [73], the Center for Epidemiologic Studies Depression Scale (CES-D) [74], and the Hospital Anxiety-Depression Scale (HADS) [75]. Anxiety can be assessed using the HADS [75] or the Beck Anxiety Inventory (BAI) [76].

Proposed guidelines for cognitive impairment screening and referral

Recent guidelines (2003) for dementia screening developed by the United States Preventative Services Task Force recommend that clinicians assess cognitive function whenever cognitive impairment or deterioration is suspected [77]. In keeping with this recommendation (given the high rates of cognitive impairment in ICU survivors), it would be ideal yet impractical to screen all ICU survivors *at hospital discharge* and subsequent follow-up visits. Therefore this is not recommended. An alternative approach is to screen only those individuals with an increased likelihood of developing cognitive impairment, although, as discussed above, only limited research has assessed causal mechanisms and risk factors of cognitive impairment following critical illness. More general evi-

dence from investigations of neuropsychological dysfunction following medical illness suggests that risk factors include advanced age, the presence of disease states with central nervous system involvement (ARDS, sepsis, bacterial meningitis, chronic obstructive pulmonary disease, diabetes, cardiovascular disease), and hypoxemia [12, 25, 78, 79, 80, 81, 82, 83, 84].

Cognitive screening using a tool such as the MMSE or Mini-cog should be performed on any individuals who answer affirmatively to questions about memory difficulties, display impaired IADLs, or have signs of cognitive impairment including ongoing delirium or memory/orientation problems (e.g., confusion, repeating the same question, losing things such as glasses, forgetting familiar names, getting lost), social problems (e.g., neglect of appearance, nutrition, hygiene, loss of interest in hobbies, social withdrawal), and/or behavioral problems (e.g., wandering, irritability, agitation, apathy) should undergo cognitive screening using a tool such as the MMSE.

Although screening at hospital discharge may result in a high false-positive rate because of the transient effects of medication and acute illness, it is important to track the patient's cognitive status during the weeks to months following ICU and hospital discharge. When patients are thought to have cognitive impairment, they should be referred to a clinical neuropsychologist for consultation and further neuropsychological evaluation. Although few neuropsychologists are actively involved in the assessment and management of survivors of critical illness at the present time, they are the appropriate professionals to assess cognitive function in these patients. It should be noted that neuropsychologists might be unavailable in small hospitals or rural areas. Neuropsychologists are typically employed in neurology, rehabilitation medicine, or psychiatry departments in most moderately sized or large medical centers. In cases where neuropsychologists are unavailable, it is appropriate to refer patients to a clinical psychologist, as they are trained in performing basic cognitive evaluations.

Conclusions

The adverse effects of critical illness on cognitive functioning are being increasingly studied and recognized by both clinicians and investigators. Although much remains unknown, it appears that a significant percentage of critically ill patients and survivors experience cognitive impairment affecting quality of life and overall daily functioning. Intensivists, particularly those that follow patients after ICU discharge, are uniquely positioned to initiate cognitive screening and subsequent referral of critically ill patients and survivors. Cognitive screening is simple, quick, and of great potential benefit, particularly in the early detection of cognitive impairment and should be widely incorporated in relevant clinical settings.

References

1. Schmitz R, Lantin M, White A (1998) Future needs in pulmonary and critical care medicine. Abt, Cambridge
2. Angus D, Musthafa AA, Clermonte G, Griffin MF, Linde-Zwirble WT, Dremsizov TT, Pinsky MR (2001) Quality-adjusted survival in the first year after the acute respiratory distress syndrome. Am J Respir Crit Care Med 163:1389–1394
3. Orme J et al (2003) Pulmonary function and health-related quality of life in survivors of acute respiratory distess syndrome. Am J Respir Crit Care Med 167:690–694
4. Weinert CR, Gross CR, Kangas JR, Bury CL, Marinelli WA (1997) Health-related quality of life after acute lung injury. Am J Respir Crit Care Med 156:1120–1128
5. Herridge MS, Cheung AM, Tansey CM, Matte-Martyn A, Diaz-Granados N, Al-Saidi F, Cooper AB, Guest CB, Mazer CD, Mehta S, Stewart TE, Barr A, Cook D, Slutsky AS and Canadian Critical Care Trials Group (2003) One-year outcomes in survivors of the acute respiratory distress syndrome. N Engl J Med 34:683–693
6. Jackson JC, Hart RP, Gordon SM, Shintani A, Truman B, May L, Ely EW (2003) Six-month neuropsychological outcome of medical intensive care unit patients. Crit Care Med 31:1226–1234
7. Savageau JA, Stanton B, Jenkins CD, Klein MD (1982) Neuropsychological dysfunction following elective cardiac operation. I. Early Assessment. J Thorac Cardiovasc Surg 84:595–600
8. Van Dijk D, Keizer AMA, Diephuis JC, Durand C, Vos LJ, Hijman R (2000) Neurocognitive dysfunction after coronary artery bypass surgery: a systematic review. J Thorac Cardiovasc Surg 120:632–639
9. Symes E, Maruff P, Ajani A, Currie J (2000) Issues associated with the identification of cognitive change following coronary artery bypass grafting. Aust N Z J Psychiatry 34:770–784
10. Newman MF, Kirchner JL, Phillips-Bute B, Gaver V, Grocott H, Jones RH, Mark DB, Reves JG, Blumenthal JA (2001) Longitudinal assessment of neurocognitive function after coronary-artery bypass surgery. N Engl J Med 344:395–402
11. Weaver LK, Hopkins RO, Chan KJ, Churchill S, Elliott CG, Clemmer TP, Orme JF, Thomas FO, Morris AH (2002) Hyperbaric oxygen for acute carbon monoxide poisoning. N Engl J Med 347:1057–1067
12. Hopkins RO, Weaver LK, Pope D, Orme JF, Bigler ED, Larson-Lohr V (1999) Neuropsychological sequelae and impaired health status in survivors of severe acute respiratory distress syndrome. Am J Respir Crit Care Med 160:50–56

13. Rothenhausler HB, Ehrentraut S, Stoll C, Schelling G, Kapfhammer HP (2001) The relationship between cognitive performance and employment and health status in long-term survivors of the acute respiratory distress syndrome: results of an exploratory study. Gen Hosp Psychiatry 23:90–96
14. Graves AB (2004) The epidemiology of dementia: Alzheimer's disease and vascular dementia. In: Nelson LM, Van Den Eeden S, Tanner C (eds) Neuroepidemiology: from principles to practice, Oxford University Press, New York
15. Pincus JH, Tucker GJ (2004) Behavioral neurology. Oxford University Press, New York
16. Hopkins RO, Collingridge D, Weaver LK, Chan K, Orme JF (2003) Neuropsychological sequelae following acute respiratory distress syndrome: two year outcome. J Int Neuropsychol Soc 9:584
17. Ho PM, Arciniegas DB, Gigsby J, McCarthy M, McDonald GO, Moritz TE, Shroyer AL, Sethi GK, Henderson WG, London MJ, VillaNueva CB, Grover FL, Hammermeister KE (2004) Predictors of cognitive decline following coronary artery bypass graft surgery. Ann Thorac Surg 77:597–603
18. Browne SM, Halligan PW, Wade DT, Taggart DP (2003) Postoperative hypoxia is a contributory factor to cognitive impairment after cardiac surgery. J Thorac Cardiovasc Surg 126:1061–1064
19. Jackson JC, Gordon SM, Hart RP, Hopkins RO, Ely EW (2004) The association between delirium and cognitive decline: a review of the empirical literature. Neuropsychol Rev 14:87–98
20. Kurz X, Scuvee-Moreau J, Vernooij-Dassen M Dresse A (2003) Cognitive impairment, dementia and quality of life in patients and caregivers. Acta Neurol Belg 103:24–34
21. Lyketsos CG, Gonzales-Salvador T, Chin JJ, Baker A, Black B, Rabins P (2003) A follow-up study of change in quality of life among persons with dementia residing in a long-term care facility. Int J Geriatr Psychiatry 18:275–281
22. Schultz SK, Ellingrod VL, Moser DJ, Kutschner E, Turvey C Arndt S (2003) The influence of cognitive impairment and psychiatric symptom on daily functioning in nursing facilities: a longitudinal study. Ann Clin Psychiatry 14:209–213
23. Bullinger M, Axouvi P, Brooks N, Basso A, Christensen AL, Gobiet W, Greenwood R, Hutter B, Jennett B, Maas A, Truelle JL, von Wild KR (2002) Quality of life in patients with traumatic brain injury-basic issues, assessment and recommendations. Restor Neurol Neurosci 20:111–124
24. Tozzi V, Balestra P, Murri R, Galgani S, Bellagamba R, Narciso P, Antinori A, Giulianelli M, Tose G, Fantoni M, Sampaolesi A, Noto P, Ippolito G, Wu AW (2004) Neurocognitive impairment influences quality of life in HIV-infected patients receiving HAART. Int J STD AIDS 15:254–259
25. Beek D van de, Schmand B, De Gans J, Weisfelt M, Vaessen H, Dankert J, Vermeulen M (2002) Cognitive impairment in adults with good recovery after bacterial meningitis. J Infect Dis 186:1047–1052
26. Steadman-Pare D, Colantonio A, Ratcliff G, Chase S, Vernich L (2001) Factors associated with perceived quality of life many years after traumatic brain injury. J Head Trauma Rehabil 16:330–342
27. Nygard L (2003) Instrumental activities of daily living: a stepping stone towards Alzheimer's disease diagnosis in subjects with mild cognitive impairment? Acta Neurol Scand 179:S42–S46
28. Withaar FK, Brouwer WH, van Zomeren AH (2000) Fitness to drive in older drivers with cognitive impairment. J Int Neuropsychol Soc 6:480–490
29. Griffith HR, Belue K, Sicola A, Krzywanski S, Zamrini E, Harrell L, Marson DC (2003) Impaired financial abilities in mild cognitive impairment: a direct assessment approach. Neurology 60:449–457
30. Wolstenholme J, Fenn P, Gray A, Keene J, Jacoby R, Hope T (2002) Estimating the relationship between disease progression and cost of care in dementia. Br J Psychiaty 181:36–42
31. Jonsson L, Lindgren P, Wimo A, Jonsson B, Winblad B (1999) Costs of Mini Mental State Examination-related cognitive impairment. Pharmacoeconomics 16:409–416
32. Rockwood K, Brown M, Merry H, Sketris I, Fisk J (2002) Societal costs of vascular cognitive impairment in older adults. Stroke 33:1605–1609
33. Johnstone B, Mount D, Schopp LH (2003) Financial and vocational outcomes 1 year after traumatic brain injury. Arch Phys Med Rehabil 84:238–241
34. Petersen RC, Stevens JC, Ganguli M, Tangalos EG, Cummings JL, DeKisky ST (2001) Practice parameter: early detection of dementia: mild cognitive impairment (an evidence based review). Neurology 56:1133–1142
35. Ho MR, Bennett TL (1997) Efficacy of neuropsychological rehabilitation for mild-moderate traumatic brain injury. Arch Clin Neuropsychol 12:1–11
36. Cicerone KD, Dahlberg C, Kalmar K, Langenbahn DM, Malec JF, Bergquist TF, Felicetti T, Giancino JT, Harley JP, Harrington DE, Herzog J, Kneipp S, Laatsch L, Morse PA (2000) Evidence based cognitive rehabilitation: recommendations for clinical practice. Arch Phys Med Rehabil 81:1596–1615
37. O'Connor DW, Pollitt PA, Hyde JB, Brook CP, Reiss BB, Roth M (1988) Do general practitioners miss dementia in elderly patients? BMJ 297:1107–1110
38. Callahan CM, Hendrie HC, Tierney WM (1995) Documentation and evaluation of cognitive impairment in elderly primary care patients. Ann Intern Med 15:422–429
39. Pisani MA, Redlich C, McNicoll L, Ely EW, Inouye SK (2003) Underrecognition of preexisting cognitive impairment by physicians in older ICU patients. Chest 124:2267–2274
40. Boise L, Camicioli R, Morgan DL, Rose JH, Congleton L (1999) Diagnosing dementia: perspectives of primary care physicians. Gerontologist 39:457–464
41. Pritchard E, Dewing J (2001) Older people with dementia in acute settings. Nurs Older People 12:21–25
42. Lang MM (2001) Screening for cognitive impairment in the older adult. Nurse Practitioner 26:26–37
43. Bergeron N, Dubois MJ, Dumont M, Dial S, Skrobik Y (2001) Intensive Care Delirium Screening Checklist: evaluation of a new screening tool. Intensive Care Med 27:859–864
44. Dubois MJ, Bergeron N, Dumont M, Dial S, Skrobik Y (2001) Delirium in an intensive care unit: a study of risk factors. Intensive Care Med 27:1297–1304
45. Ely EW, Margolin R, Francis J, May L, Truman B, Dittus R, Speroff T, Gautam S, Bernard G, Inouye S (2001) Evaluation of delirium in critically ill patients: validation of the confusion assessment method for the intensive care unit (CAM-ICU). Crit Care Med 29:1370–1379
46. Ely EW, Inouye SK, Bernard GR, Gordon S, Francis J, May L, Truman B, Speroff T, Gautam S, Margolin R, Dittus R (2001) Delirium in mechanically ventilated patients: validity and reliability of the confusion assessment method for the intensive care unit (CAM-ICU). JAMA 286:2703–2710

47. Lorentz WJ, Scanlan JM, Boorson S (2002) Brief screening tests for dementia. Can J Psychiatry 47:723–733
48. Folstein MF, Folstein SE, McHugh PR (1975) Mini-mental state a practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 12:189–198
49. Crum RM, Anthony JC, Bassett SS, Folstein MF (1993) Population-based norms for the Mini-Mental State Examination by age and education level. JAMA 269:2386–2391
50. Costa PT, Williams TF, Somerfield (1996) Early identification of Alzheimer's disease and related dementias. Clinical practice guideline. Quick reference guide for clinicians, no 19. United States Department of Health and Human Services, Public Health Service, Agency for Health Care Policy and Research, Rockville
51. Insel KC, Badger TA (2002) Deciphering the 4 D's: cognitive decline, delirium, depression and dementia-a review. J Adv Nurs 38:360–368
52. Knopman DS (1998) The initial recognition and diagnosis of dementia. Am J Med 104:2S-12S
53. Tombaugh TN, McIntyre NJ (1992) The mini-mental state examination: a comprehensive review. J Am Geriatr Soc 40:922–935
54. Tabert MH, Albert SM, Borukhova-Milov L, Camacho Y, Pelton G, Liu X, Stern Y, Devannand DP (2002) Functional deficits in patients with mild cognitive impairment: prediction of AD. Neurology 58:758–764
55. Pfeffer RI, Kurosaki TT, Harrah CH, Chance FM, Filos S (2003) Measurement of functional activities in older adults in the community. J Gerontol 37:323–329
56. Lawton MP, Brody EM (1969) Assessment of older people: self-maintaining and instrumental activities of daily living. Gerontologist 179–186
57. Karlawish JHT, Clark CM (2003) Diagnostic evaluation of elderly patients with mild memory problems. Ann Intern Med 138:411–419
58. Cromwell DA, Eager K, Poulos RG (2003) The performance of instrumental activities of daily living scale in screening for cognitive impairment in elderly community residents. J Clin Epidemiol 56:131–137
59. Scragg P, Jones A, Fauvel N (2001) Psychological problems following ICU treatment. Anaesthesia 56:9–14
60. Skozol JW, Vender JS (2001) Anxiety, delirium, and pain in an intensive care unit. Crit Care Clin 17:821–842
61. Al-Saidi F, McAndrews MP, Cheung AM, Tansey CM, Matte-Martyn A, Diaz-Granados N, Herridge M (2003) Neuropsychological sequelae in ARDS survivors. Am J Respir Crit Care Med 167:A737
62. Schelling G, Stoll C, Haller M, Briegel J, Manert W, Hummel T, Lenhart A, Heyduck M, Polasek J, Meier M, Preuss U, Bullinger M, Schuffel W, Peter K (1998) Health-related quality of life and posttraumatic stress disorder in survivors of the acute respiratory distress syndrome. Crit Care Med 26:651–659
63. Brandes D, Ben-Schachar G, Gilboa A, Bonne O, Freedman S, Shalev AY (2002) PTSD symptoms and cognitive performance in recent trauma survivors. Psychiatry Res 110:231–238
64. Ravnkilde B, Videbech P, Clemmensen K, Egander A, Rasmussen NA, Rosenberg R (2002) Cognitive deficits in major depression. Scand J Psychol 43:239–251
65. Massman PJ, Delis DC, Butters N et al (1992) The subcortical dysfunction model of memory deficits in depression: neuropsychological validation in a subgroup of patients. J Clin Exp Neuropsychol 14:687–706
66. Richards PM, Ruff RM (1989) Motivational effects on neuropsychological functioning: comparison of depressed versus nondepressed individuals. J Consult Clin Psychol 57:396–402
67. Buckelew SP, Hannay HJ (1986) Relationships among anxiety, defensiveness, sex, task difficulty, and performance on various neuropsychological tasks. Percept Mot Skills 63:711–718
68. Eysenck MW (2003) Anxiety and cognitive functioning: a multifaceted approach. In: Lister RG, Weingartner HJ (eds) Perspectives of cognitive neuroscience, Oxford University Press, New York
69. Hart RP, Kwentus JA, Taylor JR, Harkins SW (1997) Rate of forgetting in dementia and depression. J Consult Clin Psychol 55:101–105
70. McGlynn SM, Schacter DL (1989) Unawareness of deficits in neuropsychological syndromes. J Clin Exp Neuropsychol 11:143–205
71. Jones RD, Tranel D, Benton A, Paulsen J (1992) Differentiating dementia from pseudo-dementia early in the clinical course: utility of neuropsychological tests. Neuropsychology 6:13–21
72. Sheikh JL, Yesavage JA (1986) Geriatric Depression Scale (GDS): recent evidence and development of a shorter version. Clin Gerontol 5:165–173
73. Beck AT (1996) BDI-II depression inventory manual. Harcourt Brace, New York
74. Radloff LS (1977) The CES-D scale: a self report depression scale for research in the general population. Appl Psychol Meas 1:385–401
75. Zigmond AS, Snaith RP (1983) The hospital anxiety and depression scale. Acta Psychiatr Scand 67:361–370
76. Beck AT, Brown G, Steer RA (1988) An inventory for assessing clinical anxiety: psychometric properties. J Consult Clin Psychol 56:893–897
77. United States Preventive Services Task Force (2003) Screening for dementia: recommendation and rationale. Ann Intern Med 138:925–937
78. Wu JH, Haan MN, Liang J, Ghosh D, Gonzalez HM, Herman WH (2003) Impact of diabetes on cognitive function among older populations: a population based cohort study. J Clin Epidemiol 56:686–693
79. Rozzini R, Sabe T, Trabucchi M (2004) Cognitive impairment and mortality in elderly patients with heart failure. Am J Med 116:137–138
80. Johnson SC, O'Meara ES, Manolio TA, Lefkowitz D, O'Leary DH, Goldstein S, Carlson MC, Fried LP, Longstreth WT (2004) Cognitive impairment and decline are associated with carotid artery disease in patients without clinically evident cerebrovascular disease. Ann Intern Med 140:237–247
81. Kozora E, Filley CM, Julian LJ, Cullum CM (1999) Cognitive functioning in patients with chronic obstructive pulmonary disease and mild hypoxemia compared with patients with mild Alzheimer disease and normal controls. Neuropsychiatry, Neuropsychol Behav Neurol 12:178–183
82. Grant I, Prigatano GP, Heaton RK, McSweeny AJ, Wright EC, Adams KM (1987) Progressive neuropsychologic impairments and hypoxemia: relationship in chronic obstructive pulmonary disease. Arch Gen Psychiatry 44:999–1006
83. Browne SM, Halligan PW, Wade DT, Taggart DP (2003) Postoperative hypoxia is a contributory factor to cognitive impairment after cardiac surgery. J Thorac Cardiovasc Surg 126:1061–1064
84. Post J van der, Noordzij LA, de Kam ML, Blauw GJ, Cohen AF, van Gerven JM (2002) Evaluation of tests of central nervous system performance after hypoxemia for a model of cognitive impairment. J Psychopharmacol 16:337–343
85. Hopkins RO, Weaver LK, Chan KJ, Orme JF (2004) Quality of life, emotional, and cognitive functioning following acute respiratory distress syndrome. J Int Neuropsychol Soc (in press)

86. Marquis KA, Curtis JR, Caldwell ES, Davidson TA, Davis JM, Sanchez P, Rosenbaum G, Hudosn LD, Steinberg KP (2000) Neuropsychological sequelae in survivors of ARDS compared with critically ill control patients. Am J Respir Crit Care Med 161:A383
87. Jackson JC, Gordon SM, Burger D, Ely EW, Hopkins RO (2003) Acute respiratory distress syndrome and long term cognitive impairment: a case study. Archives of Clinical Neuropsychology 18:688
88. Hopkins RO, Larson-Lohr V, Weaver LK, Bigler ED (1998) Neuropsychological impairments following hanta virus pulmonary syndrome. J Int Neuropsychol Soc 4:190–196
89. Shulman KL (2000) Clock-drawing: is it the ideal cognitive screening test? Int J Geriatr Psychiatry 15:548–561
90. Borson S, Scanlan J, Brush M, Vitaliano P, Dokmak A (2000) The mini-cog: a cognitive vital signs measure for dementia screening in multilingual elderly. Int J Geriatr Psychiatry 15:1021–1027
91. Froehlich TE, Robinson JT, Inouye SK (1998) Screening for dementia in the outpatient setting: the time and change test. JAGS 46:1506–1511
92. Buschke H, Kuslansky G, Katz M, Stewart WF, Sliwinski MJ, Eckholdt HM, Lipton RB (1999) Screening for dementia with the Memory Impairment Screen. Neurology 52:231–238
93. Brodaty H, Pond D, Kemp NM, Luscombe G, Harding L, Berman K, Huppert FA (2002) The GPCOG: a new screening test for dementia designed for general practice. J Am Geriatr Soc 50:530–534
94. Brandt J, Folstein MF (2003) TICS telephone for cognitive status, professional manual. Psychological Assessment Resources, Lutz