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REVIEW

Functional Assessment Scales in a General Intensive Care Unit. A Review

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ABSTRACT

Patients in the intensive care unit (ICU) are often exposed to prolonged immobilization, thus they lose their functional ability. Therefore, it is crucial to assess patients' functional ability during their stay in and upon their discharge from the ICU. Several scales have been used so far for the assessment of functional ability, impairment and/or disability in ICU patients. These outcome measures include several assessment scales, such as the Barthel Index, the Functional Independence Measure, the Functional Status Score for the ICU, the Physical Function ICU Test Modified Rankin Scale, the Karnofsky Scale Index, the 4P questionnaire, the Glasgow Outcome Scale, and the Disability Rating Scale. The choice of the most appropriate assessment scale will depend on the specific patient population, the diagnosis and rehabilitation phase and the psychological properties of the available measurement. The aim of the present review is to describe the functional assessment scales for ICU, to examine the psychometric evidence for reliability and validity and to summarize the strengths and the weaknesses of these scales.

KEY WORDS: *functional ability; disability; impairment; scales; assessment; intensive care patients*

Abbreviations
ICU = intensive care unit
BI = Barthel index
FIM = functional independence measure
FSS-ICU = functional status score for the ICU
PFIT = physical function ICU test
MRS = modified Rankin scale
GOS = Glasgow outcome scale
DRS = disability rating scale

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INTRODUCTION

During an intensive care unit (ICU) stay, patients are often exposed to prolonged bed rest, dysfunction of vital organs, sepsis, hypoxemia and neuromuscular drug toxicity. As a result, the cardiovascular system status may be impaired and critical illness neuromuscular syndromes may occur.[1] Both of the these conditions may delay ventilator weaning and increase ICU and hospital stay.[2] In particular, the prolonged immobility and inactivity may result in loss of muscle strength and endurance, and loss of balance and neuromuscular coordination, further leading to total functional impairment, and thus impaired quality of life. Research has shown that after 1 week of bed rest, muscle strength may decrease as much as 20%, with an additional 20% loss of remaining strength occurring each subsequent week.[3] Therefore, examining the functional ability and starting early mobilization of ICU patients should increase the weaning success rate, decrease ICU and hospital stay, and improve their quality of life in the ICU and beyond.[4,5]

Due to the functional impairment of ICU patients during their stay in the unit, there is a need to assess functional ability upon their discharge from the unit. Furthermore, the cost of caring for the survivors of ICU after their discharge from the unit is quite high and the impact of an effective functional treatment for them would be significant economically and socially. Thus, the development and use of a functional

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outcome measure is necessary in order to assess and improve their functional ability, increasing the number of patients who are discharged from ICU. However, the choice of a functional assessment outcome measure is crucial for the evaluation and choice of the best provision of their rehabilitation. Thus, selecting an inappropriate functional assessment outcome measure may lead to incorrect conclusions regarding the benefits of treatment.[6]

Few outcome measures have been used to assess the functional ability of ICU patients.[7-10] Furthermore, Nickol et al[11] and Shukla et al[12] in their reviews discussed general outcome measures for only traumatic brain injury (not in an ICU setting), including quality of life measures. Also, Black et al[13] describe generic and disease-specific outcome measures of adult critical care survivors. More recently, Gosselink et al[14] reviewed outcome measures for assessing sedation, level of cooperation, cardiorespiratory status, muscle and respiratory strength, and functional performance of ICU patients. There has not been any recent review examining the use and psychometric properties for only functional assessment scales in a general ICU setting, which includes patients with different pathologies, e.g., traumatic brain injuries, general surgeries, respiratory diseases, neuromuscular diseases, etc. Therefore, the aims of the present study were (a) to describe the functional outcome measures of ICU patients, i.e., purpose, number of items, description of subscales, response format and scoring, (b) to examine the psychometric evidence for reliability (internal consistency and test-retest) and validity (content, construct, criterion and discriminant), and (c) to summarize the strengths and the weaknesses of the existing functional outcome measures.

CHARACTERISTICS OF A MEASUREMENT SCALE OF INTENSIVE CARE PATIENTS

It is useful to determine the characteristics of an assessment scale of intensive care patients. In order for an assessment tool to be used, it should be reliable, reproducible, validated, easy to use and sensitive to any clinical change. Firstly, the scale should be simple to administer to the patient population. The patients' responses should be scored only by the scale instructions and not subjectively. Second, the scale must be reliable which means that it should contain three measurement properties: internal consistency, test-retest reliability and measurement error. Reliability refers to the degree to which the measurement instrument is free from measurement error[15] and estimates the extent to which scores for patients who have not changed are the same for repeated measurements under several conditions: (a) using different sets of items from the same measurement tool (internal-consistency), (b) across time (test-retest), (c) by different persons (i.e., raters) on the same occasion (inter-rater) and (d) by the same person (i.e., raters or responders) on different occasions (intra-rater).[16] Third, the scale must be validated, which means that the instrument measures the construct(s) it purports to measure.[15] Validity contains three measurement properties: content validity, construct validity and criterion validity. Fourth, the results of the scale should be reproducible over time. It should have sensitivity and responsiveness to detect small changes which impact function and not demonstrate a ceiling effect as functional ability improves, allowing discrimination between high functioning survivors. Lastly, the scale should ideally be free to administer (i.e., no copyright fee).[11]

DESCRIPTION OF THE FUNCTIONAL ASSESSMENT SCALES IN AN ICU

The most common scales in the literature which have been used in a general ICU are the following: the Barthel Index, the Functional Independence Measure, the Functional Status Score for the ICU, the Physical Function ICU Test Modified Rankin Scale, the Karnofsky Scale Index, the 4P questionnaire, the Glasgow Outcome Scale, and the Disability Rating Scale (Table 1).

(A) BARTHEL INDEX (BI)

The Barthel Index (BI)[17] has been used to measure physical functioning and was improved upon by the Functional Independence Measure (FIM). It measures the capacity to perform 10 basic activities of daily living. In particular, items are divided into groups that relate to self-care (feeding, grooming, bathing, dressing, bowel and bladder care and toilet use) and mobility (ambulation, transfers and stairs climbing). It gives a quantitative estimation of the patient's level of dependency with scoring from 0 (totally dependent) to 100 (totally independent). The range of BI was described by classifying the patients as having minimal or no disability (BI score, >90), moderate disability (BI score, 55–90) or severe disability (BI score <55). This tool has been reported to have high reliability.[18]

(B) FUNCTIONAL INDEPENDENCE MEASURE (FIM)

The FIM[19] is the most widely accepted functional assessment tool used for assessing basic functional activities of ICU patients and their progress during in-patient rehabilitation.[20,21] Two separate domains of items comprise the motor domain consisting of 13 items and the cognitive domain consisting of 5 items. The FIM is a multi-dimensional measure which assesses self-care, sphincter control, transfers, locomotion, communication, and social cognition in addition to cognitive and motor sub-scales. FIM scores range from 1 to 7; a FIM item score of 7 is categorized as "complete independence," while a score of 1 is "total assistance". Each dimension is then added, yielding a possible total score between 18 (complete dependence) and 126 (complete independence). Precision, inter-rater reliability and validity have been established.[22-24] At

TABLE 1. Functional Assessment Scales in the ICU

1) ***Barthel Index (BI):*** it measures the capacity to perform 10 basic activities of daily living
- self-care (feeding, grooming, bathing, dressing, bowel & bladder care & toilet use) & mobility (ambulation, transfers and stairs climbing)
- scoring ranges from 0 (totally dependent) to 100 (totally independent)
- BI index score >90: minimal or no disability
- BI index 55-90: moderate disability
- BI index <55: severe disability

2) ***Functional Independence Measure (FIM):*** the most widely employed functional assessment tool
- motor domain (13 items)
- cognitive domain (5 items)
- FIM scores: 1 (total assistance) - 7 (complete independence) for each variable
- FIM total score: 18 (complete dependence) - 126 (complete independence)

3) ***Functional Status Score for the ICU (FSS-ICU):*** consists of 3 pre-ambulation categories (rolling; supine to sit transfer; & unsupported sitting) and 2 ambulation categories (sit to stand transfers; & ambulation)
- Rating: 1 (total dependent assistance) - 7 (complete independence) scale
- Score: 0-35 (0 score: unable to perform a task due to physical limitations or medical status)

4) ***4P questionnaire:*** evaluates physical and psychosocial problems following ICU recovery
- 4P: Patients, Physical, Psychosocial and Problems
- 4P comprises 53 items: 16 physical items, 26 psychosocial items and 11 follow-up ICU care items, scored on a 5-point Likert scale measuring level of agreement from "strongly agree" to "do not agree at all"

5) ***Physical Function ICU Test (PFIT):*** used with critically ill patients who may not be able to mobilize away from the bedside, employing 4 domains
- amount of assistance for sit to stand, rated from 0 (no physical assistance required) to 3 (assistance of 3 people required)
- strength for shoulder flexion and knee extension (rated on the Oxford Muscle Test Scale)
- marching in place (number of steps taken & the time required to complete these steps), &
- an upper extremity endurance task of arm elevation to 90˚ shoulder flexion (number of times both upper extremities are lifted above 90˚ of shoulder flexion)

6) ***Karnofsky Performance Scale Index:*** a descriptive, ordinal scale that ranges from 100 (good health) to 0 (dead) and emphasizes physical performance and dependency
- Karnofsky index of 70–100: a favorable functional outcome measure

7) ***Modified Rankin Scale (mRS):*** quantifies independence and disability, with a scale of 6 grades (0-5)
- 0, no symptoms;
- 1, no significant disability despite symptoms;
- 2, slight disability;
- 3, moderate disability;
- 4, moderately severe disability

8) ***Glasgow Outcome Scale (GOS):*** provides a global assessment of function (see text for modified GOS scales)
- score 1: good recovery;
- score 2: moderate disability;
- score 3: severe disability;
- score 4 vegetative state;
- score 5: death

9) ***Disability Rating Scale (DRS):*** a common outcome measure of impairment, disability and handicap; the scale is intended to assess accurately general functional changes over the course of recovery
- Impairment ratings: "Eye Opening", "Communication Ability" and "Motor Response"
- Level of disability: Ability for "Feeding," "Toileting" and "Grooming"
- Handicap: "Level of Functioning" and "Employability"
- Rating for each functioning area: scale of 0 to either 3 or 5
- Maximum score (29): extreme vegetative state
- Lowest score (0): a person without disability

rehabilitation discharge and particularly at one year post injury, ceiling effects of the FIM were observed in the moderate and severely neurologically impaired population.[25]

(C) FUNCTIONAL STATUS SCORE FOR THE ICU (FSS-ICU)

The FSS-ICU[21] is an ordinal scale similar to FIM used for in-patient rehabilitation in ICU. The FSS-ICU consists of 3 pre-ambulation categories: (a) rolling, (b) supine to sit transfers and (3) unsupported sitting; and 2 ambulation categories: (a) sit to stand transfers and (b) ambulation. Each functional category is rated using a 1 (total dependent assistance) to 7 (complete independence) scale with a score from 0-35. A score of 0 is assigned if a patient is unable to perform a task due to physical limitations or medical status. The reliability and validity of the FSS-ICU has not been previously reported.[10]

(D) 4P QUESTIONNAIRE

Akerman et al[26] developed the 4P questionnaire for evaluating physical and psychosocial problems following ICU recovery. The questionnaire was named 4P after its major content: Patients, Physical, Psychosocial and Problems. It comprises 53 items: 16 physical items, 26 psychosocial items and 11 follow-up ICU care items. All items were based on a literature review and from clinical and theoretical experiences as ICU nurses regarding health and recovery after ICU26.[24] The items were scored on a 5-point Likert scale measuring level of agreement from "strongly agree" to "do not agree at all". There was also an option to answer "not relevant". The questionnaire showed good construct validity in all three sets and had strong factor loadings for all three sets. The questionnaire has good concurrent validity compared with the Questionnaire SF-12. Internal consistency was shown to have reliable indices and stability reliability on retesting was good for the physical and psychosocial factors.[26]

(E) PHYSICAL FUNCTION ICU TEST (PFIT)

The PFIT[27] is a reliable and responsive outcome measure that was developed for use with critically ill patients who may not be able to mobilize away from bedside. The test had 4 domains and has been shown to be both reliable and sensitive to change.[27] The 4 domains are: (a) amount of assistance for sit to stand, (b) strength for shoulder flexion and knee extension, (c) marching in place, and (d) an upper extremity endurance task of arm elevation to 90° shoulder flexion. The amount of assistance required to stand is rated from 0 (no physical assistance required) to 3 (assistance of 3 people required). Strength for shoulder flexion and knee extension is rated on the Oxford Muscle Test Scale. For marching in place, the examiner records the number of steps taken and the time required to complete these steps. For the upper extremity endurance component, the numbers of times both upper extremities are lifted above 90° of shoulder flexion are recorded as well as the time to complete this task. The PFIT has demonstrated reliability and good responsiveness to change and thus may be advantageous to use as a supplement for documenting changes in mobility for a sub-population identified in the critical care environment.[27]

(F) KARNOFSKY PERFORMANCE SCALE INDEX (KARNOFSKY STATUS SCALE/ KARNOFSKY INDEX/ KARNOFSKY SCORE)

The Karnofsky Index score[28] is among the recommended outcome measures for scoring of intensive care patients.[13] It is used to give an indication of the patient's functional status. This measurement tool is a well-established tool with proven validity and reliability for the assessment of independent functioning in the critically ill patients.[13] It is a descriptive, ordinal scale that ranges from 100 (good health) to 0 (dead) and emphasizes physical performance and dependency. A Karnofsky index of 70–100 is generally considered a favorable functional outcome measure.

(G) MODIFIED RANKIN SCALE (MRS)

The mRS[29] quantifies independence and disability rather than performance of specific tasks. The scale consists of 6 grades from 0 to 5, as follows: 0, no symptoms; 1, no significant disability despite symptoms; 2, slight disability, whereby the subject is unable to carry out all previous activities, but is able to look after own affairs without assistance; 3, moderate disability when the subject requires some help, but is able to walk without assistance; 4, moderately severe disability with the subject being unable to attend to own bodily needs without assistance; 5, severe disability when the subject is bedridden, incontinent and requires constant nursing care and attention.[30] The scale was found to have good inter-rater agreement in acute stroke patients, but problems with the interpretation and relevancy of the scale in the hospitalized setting raise concerns about validity.[31]

(H) GLASGOW OUTCOME SCALE (GOS)

The GOS[32] provides a global assessment of function and has been used in ICU settings.[33] It is well validated[34] and has a score of 1 which indicates a good recovery; 2 moderate disability; 3 severe disability; 4 vegetative state; and 5 death. In particular, the range of outcomes was described by classifying the patients as having minimal or no disability (Glasgow Outcome Score, 1), moderate disability (Glasgow Outcome Score 2), or severe disability (Glasgow Outcome Score, 3 or 4). Due to some shortcomings[35], the GOS was modified and a structured interview was proposed to accurately categorize patient's disability. This version is called the GOS-Extended (GOSE/GOSe). This extended version of the scale separates each of the three higher function categories into two, thus making eight categories in total. It has been prospectively demonstrated that the validity criterion of the GOSe generally exceeds the GOS and it is more sensitive to change than the GOS. The GOSe has good reliability in neurological patients.[36,37] Recently an alternate GOSE rating system has been proposed. First, patients are rated on GOS scores, and second, they are subcategorized on

GOSE scores, using structured questionnaire and narratives with central review committee. Through this system, GOSE scores can be categorized more accurately[38]. The GOS includes good recovery and moderate disability and the GOSe includes severe disability, vegetative state and death.[12]

(I) DISABILITY RATING SCALE (DRS)

The DRS[39] is a common outcome measure of impairment, disability and handicap. The scale is intended to assess accurately general functional changes over the course of recovery. The first three items ("Eye Opening", "Communication Ability" and "Motor Response") reflect impairment ratings. Ability for "Feeding," "Toileting" and "Grooming" reflect level of disability. The "Level of Functioning" and "Employability" reflects handicap. Each of the areas of functioning is rated on a scale of 0 to either 3 or 5, with the highest scores representing the higher level of disability. The maximum score is 29 (extreme vegetative state) and 0 for a person without disability. Many studies have reported good reliability and validity coefficients for the DRS.[40]

DISCUSSION

Experimental studies have examined the functional ability of ICU patients during their stay and after discharge by using valid scales.[7-10] However, no previous study has reviewed the use and psychometric properties of only functional assessment scales in a general ICU setting. Therefore, the purpose of the present review was to assess only the functional assessment scales for ICU patients, to examine reliability and validity of them, and to summarize their strengths and weaknesses.

Scales are usually the preferred method of assessing the functional outcome measure of patients. However, because scales are worded, scored, designed, and constructed differently, clinicians must be cautious when choosing an appropriate outcome measure. Different ICUs, such as stroke, cardiac, surgery, or respiratory units, determine specific functional outcome measures relevant to patient population. Outcome measures can also be classified according to their utility in specific settings, like acute stage, in-patient rehabilitation, and at follow up after discharge. Before choosing an outcome measure, one should first determine what needs to be measured, be it functional activity, impairment, capacity, performance, disability, and/or handicap and what type of administration one wants to be selected, e.g. testing in a laboratory, observation, or report by the patient. Each instrument should be reviewed for actual content and syllabus and instructions required for administration and scoring.[12]

Limitations still exist in all used scales when assessing patients in the ICU. First, there is a need for sufficient details in the questionnaire and in the instructions for the individual collecting the data to have reliable and valid responses. Second, a reasonable period of time is needed for improvement and stabilization of neurological, surgical or respiratory patients' recovery before assessment. Therefore, a lot of useful time may be lost during the injury incidence and the functional measure which means drop-outs and loss of follow-up in clinical trials.[11]

The outcome measures that have been reviewed in the present study appear to have specific shortcomings. Zanni et al[21] reported that there are no methods for assessing functional status that have been specifically validated in ICU patients. Regarding the use of FIM for critical care environments, it is often employed in a subjective self-report format several months after ICU admission.[41] Furthermore, several items of the total FIM cannot be assessed in an ICU setting (e.g., stairs) and a total score cannot be given. Although the ability of this tool to detect changes in the rehabilitation setting is high, there is a ceiling effect which limits the usefulness of it in assessing change after discharge from rehabilitation.[25] Also, it consolidates all transfer types (from bed mobility to standing transfers) into one task, which may lead to a floor effect for chronically critically ill populations.[10] Gosselink et al[42] report that the validated FIM does not evaluate basic mobility skills (e.g., rolling), which are more relevant for weak ICU patients. Until further validation work is done, this limitation is common to all publications in this field and was addressed through using methods similar to prior ICU publications.[43,44]

However, the FSS-ICU includes tasks more appropriate for critically ill patients. The relevant to the ICU setting functional tasks, such as (1) rolling, (2) transfer from supine to sit, (3) sitting at the edge of bed, and (4) transfer from sit to stand, are evaluated. These 4 tasks, plus ambulation, were combined in the cumulative FSS-ICU, which is a simple sum of the 5 individual scores.[21] However, reliability and validity of this new measure have not yet been reported.

Regarding the PFI test, although it is a reliable and responsive outcome measure, it is only described in a small sample of patients who were able to sit out of bed, stand from a chair, and march in place.[27] Many patients in ICU are not able to perform these out of bed tasks. Additionally, the PFIT does not assess ambulation. Therefore, the PFIT is likely to have both a floor and ceiling effect in an ICU population.[10] Future research should aim to develop a PFIT score and investigate the ability of the PFIT to predict ICU readmission risk and functional outcome including ambulation.[27]

The Karnofsky Index has been used to evaluate the 2–3 years of surviving re-admitted patients after discharge and identify possible determinants of their functional outcome.[33] Riachy et al[45] assessed the functional outcome of acute stroke patients at ICU discharge. The measurement properties of the Karnofsky Index have been subject to some limited investigation in critical care survivors. There is some evidence of their construct and criterion validity and their responsiveness, but reliability has not been investigated.[13]

The Barthel Index has been used widely, because it is short and it does not need experienced examiner. It has been used to measure physical functioning in clinical settings, especially neurological patients (i.e., stoke and traumatic brain injuries)

at ICU discharge[7,46,47] and at baseline, discharge and follow up.[48] However, its psychological properties have received little attention, thus it is not possible to comment on their usefulness in critical care.[27] Therefore, due to limited research regarding its measurement properties in critical care patients and survivors, future studies should investigate the reliability, validity and responsiveness in the ICU environment.

The DRS is a common outcome measure of impairment, disability and handicap of neurological patients from the stage of coma in the ICU to their release to the community. Although the DRS is short and has an easy scoring system, it can assess general functioning rather than specific functional changes and cannot detect small functional changes in patients with mild impairment.[49] The major disadvantages of DRS relate to the fact that it requires more specialized training for its implementation by the rater, and to a high inter-rater variability.[12] The mRS quantifies independence and disability rather than performance of specific tasks particularly in stroke patients. Jeng et al[46] assessed the functional outcomes of 850 acute stroke patients at discharge from an ICU. Further studies should explore the Modified Ranking Scale's validity in the ICU setting.

The present study is an overview, as the authors have not conducted a systematic review and testing of the described assessment scales. Future studies may proceed to examine and test additional types of reliability and validity in all the existing functional scales with large ICU samples. Further investigations should focus on cross-cultural translation in the Greek language of the current instruments. The content validity must be assessed using a judge expert panel and the construct validity by using exploratory and confirmatory factor analysis. The exploratory factor analysis may examine the factor structure of the instrument. The confirmatory factor analysis further assesses the factorial validity supporting the instrument's model fit. Lastly, in future studies, it would also be beneficial to investigate whether a tool is used for research and/or for clinical purpose.

CONCLUSION

Assessing functional outcome is considered standard of care for the rehabilitation personnel, and is essential to document the effectiveness of treatment interventions. An important consideration when choosing a functional scale in the ICU is to determine first the patient population, its characteristics and its rehabilitation stage. Some measures may be most appropriate for individuals with severe activity limitations who are not able to sit, stand and walk, while other measures are most appropriate for patients who function at a higher level. The examiner may include a series of measures, some of which are not appropriate for patients at initial enrolment into a study, but are appropriate as the patient's condition improves minimal activity restrictions, and is ready for discharge to an assisted or independent living environment. To date only few outcome measures have been developed specifically for chronically critically ill patients to measure function in a long-term acute care hospital setting. However, these current outcome measures have some limitations with their psychological properties. Therefore, further research should investigate the utility and the cross cultural validation/reliability of the existing functional outcome measures.

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