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Physical Function Assessment Tools in the Intensive Care Unit: A Narrative Review

Bela Agarwal,* Damini Aglawe, & Bhoomika Sawant

MGM School of Physiotherapy, MGM Institute of Health Sciences, Navi Mumbai, India

*Address all correspondence to: Dr. Bela Agarwal, MGM School of Physiotherapy, MGM Institute of Health Sciences, Navi Mumbai, India; Tel.: +91-9819000674, E-mail: bagarwal@mgmsopnm.edu.in

ABSTRACT: Prolonged immobilization and bed rest in critically ill patients leads to loss of physical functional ability. Therefore, assessment of physical functional ability during intensive care unit (ICU) stay and at discharge plays a central role in planning early intervention and instituting rehabilitation measures to improve physical function outcomes. Various scales have been developed, modified, and applied to assess functional ability, impairments, and disabilities in ICU patients. The selection of the most appropriate assessment scale depends on the specific patient population, the diagnosis, the phase of rehabilitation and the psychometric properties of the measurement tool. This narrative review aims to describe the various physical function assessment tools applicable to patients in the ICU, to determine the psychometric evidence for reliability and validity, and to summarize the strengths and weaknesses of each of these scales in order to enable clinicians to make an informed choice while selecting outcome variables during rehabilitation of patients in the critical care unit.

KEY WORDS: intensive care, physical function, assessment, outcome measures

ABBREVIATIONS: BADL, basic activities of daily living; **BI**, Barthel index; **CPAx**, Chelsea critical care physical assessment tool; **DRS**, disability rating scale; **FIM**, functional independence measure; **FSS-ICU**, functional status score–ICU; **GOS**, glasgow outcome scale; **ICU**, intensive care unit; **KPS**, Karnofsky performance scale; **MBI**, modified Barthel index; **MDC**, minimal detectable change; **mRS**, modified rankin scale; **PCFS**, post COVID-19 functional status score; **PFIT**, physical function ICU test; **PRFS-ICU**, patient-reported functional scale–ICU

I. INTRODUCTION

Physical function is the ability to carry out various activities that require physical capability and is the key to healthy functioning of the body. It ranges from self-care to more vigorous activities requiring higher degrees of mobility, strength, or endurance.[1,2] Patients with critical illness are exposed to prolonged bed rest and immobilization leading to decreased physical activity and loss of functional abilities, which results in decline or dysfunction of organ systems.[1] Continuous intensive or invasive monitoring; support of airways, breathing, or circulation; stabilization of acute or life-threatening medical problems; comprehensive management of injury and/or illness; and maximization of comfort for patients admitted in intensive care units (ICUs) confines patients to their beds and decreases physical activity.[3]

Considerable functional disabilities in activities of daily living is seen in patients post ICU-discharge.[4] Reduced physical activity and functional ability is a significant problem in ICU survivors.[5] Therefore, assessment of physical function during ICU stay is valuable in gaining perspective on current functional status and to further plan appropriate treatment of the individual. Functional limitations of ICU survivors often remain unassessed. Hence, measuring physical functioning early and longitudinally in the ICU is important to determine patients at risk of poor physical outcomes, monitor intervention efficacy, and inform recovery trajectories. These insights are important to improve the outcomes of critically ill patients.[6]

Several scales have been used to assess functional ability, impairment, and disability in ICU patients. Functional scales in ICU have been administered mainly for evaluation of patient physical activity at ICU admission and during ICU stay. The choice of most appropriate assessment scale depends on the specific patient population, the diagnosis and rehabilitation phase, and the psychometric properties of available measurements. Selecting an appropriate functional assessment outcome measure is crucial for evaluation, goal setting, and administration of the best possible rehabilitation measures. The aim of the current narrative review is to describe the commonly used tools for measuring physical function in patients admitted to the ICU along with the psychometric properties of the scales and their applicability in various patient groups.

II. METHODOLOGY

A literature search was performed using PubMed, Google Scholar, Cochrane Library, and Science Direct. Among the 495 titles/abstracts identified using the key words "physical function," "functional ability," "disability," "impairment," "scales," "assessment," "intensive care unit," "critical-illness" with Boolean operators "AND" and "OR;" 64 full text articles were examined and evaluated for inclusion. Reference lists of relevant articles were examined to identify additional eligible studies. Preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidance was used.

A. Inclusion Criteria

Full-text articles published in English, reviews and randomized control trials utilizing these scales, and articles reporting the psychometric properties of the physical function scales applicable to patients with critical illness were included in this review.

B. Exclusion Criteria

Articles published in languages other than English, studies on neonatal and pediatric populations, studies not reporting description or psychometric properties of the measurement tools and studies reporting health-related quality of life, mental health, and aspects other than physical function were excluded.

III. RESULTS

Sixteen scales were identified through the literature review. A brief summary of each scale, domains of function evaluated by the scale, scoring system, and psychometric properties of each scale is provided to enable clinicians to make an informed choice while selecting measurement tools for evaluation of physical function in the ICU.

A. Glasgow Outcome Scale

Optimal arousal and adequate neurological function is mandatory to perform physical activities. The glasgow outcome scale (GOS), first published by Jennett and Bond in 1975, provides a global assessment of function, has been consistently used in ICU settings, and is highly cited in studies on brain injury. A GOS score of 1 = good recovery, 2 = moderate disability, 3 = severe disability, 4 = persistent vegetative state, and 5 = death. The range of outcomes includes minimal or no disability (GOS 1), moderate disability (GOS 2), and severe disability (GOS 3 or 4).[7,8,9] McMillan et al. charted the development, refinement, and application of GOS. Other versions of the original GOS are the glasgow outcome scale-extended (GOS-E), the glasgow outcome at discharge scale (GODS), and the GOS pediatric revision.[9] Wier et al. reported higher sensitivity of GOS-E than GOS.[10] Excellent inter-rater reliability $k = 0.95$ was reported by the developers of GOS, while other studies involving trained raters with direct or simultaneous contact with patients reported low inter-rater reliability $k = 0.76$.[11]

B. Richmond Agitation-Sedation Scale

Patients in the ICU often demonstrate altered neurological status with agitation and require sedation in order to ensure synchrony between the ventilators and patient and comfort with artificial intubation. However, prolonged sedation can substantially impact the length of ICU stay and related complications. The richmond agitation-sedation scale (RASS) was developed by critical care physicians, nurses, and pharmacists with an objective of enhancing communication between care givers and optimizing rehabilitation. The RASS is a 10-point scale ranging from +4 to −5, where +4 denotes a combative stage; +2/3, agitation; +1, restlessness; and 0, alert and calm; −1 denotes drowsy; and −5, unarousable of sedation. Sessler et al. tested the reliability and validity of the RASS in adult critically ill patients. Excellent inter-rater reliability ($r = 0.922–0.983$) is reported in ventilated and nonventilated patients with medical and surgical conditions.[12]

C. Barthel Index

The Barthel Index (BI) was developed by Mahoney and Barthel in 1955. It scores the ability of a patient to perform 10 basic self-care activities of daily living. Periodical reassessment can be performed to assess the progress of physical activity status. Items include self-care activities like feeding, grooming, bathing, dressing, bowel and bladder care and toileting, and mobility activities such as ambulation, wheelchair transfers, and stair climbing. The scale gives a measurable estimation of the patient's level of independence with scoring from 0 (totally dependent) to 100 (totally independent). A score of 100 indicates that the patient is able to feed, dress, bathe, walk, and ascend and descend stairs independently. The BI classifies the patients as having minimal or no disability (BI score > 90), moderate disability (BI = 55–90), or severe disability (BI score < 55).[13] Statistically high significance in coefficients of concordance between the four different methods of BI rating have been reported (Kendall's coefficient of concordance $W = 0.93$; $p < 0.001$). Internal consistency of BI was found to be 0.87.[14]

D. Modified Barthel Index

Barthel Index was considered a standard measure of ADLs until Shah et al. in 1989 reported that BI sensitivity can be improved by variations in scoring of each ADL in the scale. The updated BI is known as the Modified Barthel Index (MBI). The items of the scale remain the same, whereas the scoring of each ADL is expanded to include more categories to record each item. A score of 0 indicates total dependence while 100 indicates complete independence. The MBI also serves as a predictor of hospital discharge. A score < 40 indicates unlikely chances of discharge and a score > 85 indicates early discharge. The MBI is reported to have greater sensitivity, improved reliability, and excellent test-retest reliability compared to the original BI. The ICC of the MBI was reported to be 0.94, indicating high test-retest reliability. The MDC (minimal detectable change) of the MBI was 19% indicating that MBI scores are less affected by random measurement errors.[15,16]

E. Functional Independence Measure

The functional independence measure (FIM) was developed in 1983 by a task force created by the American Congress of Rehabilitation Medicine and the American Academy of Physical Medicine and Rehabilitation and headed by Carl Granger and Byron Hamilton.[17] It is a widely used functional evaluation tool for assessing patients' basic functional activities and their progress during their ICU stay and in-patient rehabilitation. It includes two separate domains: the motor domain consists of 13 items and the cognitive domain consists of 5 items. The FIM is a multidimensional measure assessing self-care, sphincter control, transfers, locomotion, communication, and social cognition. FIM scores range from 1 to 7:7 indicates complete independence, while 1 indicates total assistance. The sum of all components generates a total score between 18 (complete dependence) and 126 (complete independence). The precision, inter-rater reliability, and validity of FIM have been well established at rehabilitation discharge and particularly at one-year post injury. Ceiling effects of the FIM have been studied in patients with moderate and severely neurological impairment. Previous studies indicate that FIM scores are associated with mortality in critically ill elderly patients and difficulty in weaning from a mechanical ventilator.[18,19]

F. Functional Status Score–ICU

The FSS-ICU is an ordinal scale used for in-patient rehabilitation in the ICU. It consists of three preambulation categories: rolling, supine-to-sit transfers, and unsupported sitting; and two ambulation categories: sit-to-stand transfers and ambulation. Each category is rated using score values from 1 (total dependent assistance) to 7 (complete independence) and total scores range 0–35. If a patient is unable to perform a task due to physical limitations or medical status, a score of 0 is assigned. The reliability and validity of the FSS-ICU had not been reported[20] until Huang et al. conducted a clinimetric analysis and concluded that it has good internal consistency and is a valid and responsive measure of physical function.[21]

G. 4P Questionnaire

The 4P questionnaire was named after its major content: patients, physical, psychosocial, and problems. This questionnaire was developed by Eva Akerman et al. in 2008 to assess ICU patients' physical and psychosocial problems after ICU discharge, and to recognize the need for follow-up.[22] It evaluates physical and psychosocial problems following ICU recovery and includes 53 items: 16 physical, 26 psychosocial, and 11 follow-up. The items are scored on a 5-point Likert scale from "strongly agree" to "do not agree at all." There is also a "not relevant" option. The questionnaire shows good construct validity in all three sets and has strong factor loadings for all three sets. Internal consistency (Cronbach's α for physical problems = 0.75, psychosocial problems = 0.81, follow-up = 0.91) has been shown to have reliable indices and good stability reliability on retesting for the physical and psychosocial factors.[23]

H. Physical Function ICU Test

The physical function ICU test (PFIT) is a reliable outcome measure developed for critically ill patients who may be unable to get out of bed. The four test domains are assistance required to perform sit-to-stand transfers, strength of shoulder flexion, strength of knee extension, and marching in place. The assistance required to stand is rated from 0 (no physical assistance required) to 3 (assistance of three 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 them. The PFIT has demonstrated reliability and good responsiveness to change.[24] Denehy et al. conducted a nested cohort study to test the clinimetric properties of PFIT. Their observations indicate that scoring of sit-to-stand assistance is subjective, and cadence cut-points used may not be generalizable to a large population.[25]

I. Karnofsky Performance Scale Index (Karnofsky Status Scale/Karnofsky Index/Karnofsky Score)

The Karnofsky Index is a highly recommended outcome measure for scoring ICU patients and emphasizes physical performance and dependency to indicate the patient's functional status. It is a descriptive, ordinal scale that ranges from 100 (good health) to 0 (dead). A Karnofsky Index of 70–100 is generally considered a favorable functional outcome measure. This measurement tool is well-established with proven validity and reliability for the assessment of independent functioning in critically ill patients.[26] Grieco et al. investigated the Karnofsky Performance Scale (KPS) as a measure of quality of life, reporting it as a reliable and valid global measure although it does not sufficiently capture the quality-of-life domain.[27] Nikoletti et al.[28] reported the use of KPS as a gold standard for quantifying physical function in cancer patients. A comparative study of KPS and its modified version Throne-KPS (T-KPS) suggested that T-KPS may be a more objective and sensitive measure of physical function in cancer patients residing in terminal care facilities. T-KPS avoids reference to the location of care. The middle and lower levels of T-KPS are modified such that they provide clinically relevant change in function as compared to KPS.[28] A study undertaken by Carlos et al. to identify quality-of-life predictors in Brazilian women undergoing palliative care reported that lower KPS scores were closely related to reduced quality of life.[29] Recently, Nagihan et al. evaluated the reliability and validity of KPS and found a strong positive correlation (r = 0.895) between KPS and Katz ADL and a strong negative correlation (r = –0.894).[30]

J. Modified Rankin Scale

Rather than performance of specific tasks, the modified rankin scale (mRS) quantifies independence and disability. The scale consists of 6 grades from 0 to 5 as follows: 0 = no symptoms; 1 = no significant disability despite symptoms; 2 = slight disability, with the subject unable to carry out all previous activities but able to look after their own affairs without assistance; 3 = moderate disability, with the subject requiring some help but able to walk without assistance; 4 = moderately severe disability, with the subject being unable to attend to bodily needs without assistance; and 5 = severe disability, with the subject bedridden, incontinent, and requiring constant nursing care and attention.[31,32] The scale was found to have good inter-rater agreement ICC = 0.675 in acute stroke patients, but problems with interpretation and relevancy in the hospital setting have been reported.[33]

K. Disability Rating Scale

The disability rating scale (DRS) is a common outcome measure used to determine impairment, disability, and handicap. The scale assesses general functional changes over the course of recovery. The first three items—"Eye Opening," "Communication Ability," and "Motor Response" indicate impairment ratings. "Feeding," "Toileting," and "Grooming" indicate level of disability. "Level of Functioning" and "Employability" indicate handicap. Each area of functioning is rated on a scale of 0 to 3 or 5, higher scores representing higher levels of disability. The maximum achievable scores are 29 (extreme vegetative state) and 0 (no disability).[34] Eliason et al. reported good reliability and validity coefficients for DRS in traumatic brain injury patients. Significant correlation was reported between initial DRS scores and length of hospital stay ($r = 0.50$, $p < 0.01$); at discharge DRS scores ($r = 0.66$, $p < 0.01$); and discharge status ($r = 0.40$, $p < 0.01$).[35] Struchen et al. reported that DRS provides a greater range of scores and is thus more sensitive to change than GCS.[36]

L. Patient-Reported Functional Scale–ICU

The patient-reported functional scale (PRFS-ICU) is a recently developed self-reported tool that measures patients' perceptions of their ability to perform six activities— rolling in bed, sitting at the edge of the bed, sit-to-stand activity, bed-to-chair transfer, ambulation, and stair climbing. Items are scored from 0 (unable) to 10 (able to perform at pre-ICU level) with a maximum of 60.[37]

M. Katz Index of Independence in Activities of Daily Living

The Index of Independence in Activities of Daily Living, commonly known as the Katz Index, was developed by Dr. Sidney Katz in 1963. It was developed as a tool to measure function which can be used in objective evaluations of chronically ill and aging populations and the effectiveness of treatment in the same. The index is based on primary biological and psychosocial functions, and provides an objective guide to the course of chronic illness and aids in rehabilitation and summarizes six functions, namely, bathing, dressing, going to toilet, transferring, continence, and feeding.[38,39] Patients are scored 1 for "yes" and 0 for "no," for independence in each of the six functions. A score of 6 indicates full function; 4, moderate impairment; and 2 or less, severe functional impairment.[40] Haack et al. in 2019 reported that the Katz Index of ADL is significant in predicting hospital discharge and the need for disposition to outpatient or rehabilitation facilities for long-term rehabilitation. Katz et al. assessed the inter-rater reliability, reporting only insignificant differences between observers.[39,41]

N. Chelsea Critical Care Physical Assessment Tool

The development of this tool began in 2009 by Evelyn J. Corner, with the aim to formulate a bedside scoring system to evaluate and grade physical morbidity in the critically ill population.[42] The Chelsea Critical Care Physical Assessment Tool (CPAx) is a numeric and pictorial composite of 10 common components: physical function; respiratory function, cough, moving within the bed, supine-to-sitting transfer to the edge of the bed, dynamic sitting, standing balance, sit-to-stand transfer, transferring from bed to chair, stepping, and grip strength. These are graded on a 6-point Guttman

Scale, from complete dependence to independence (0 to 5). The component scores are added to produce a total score out of 50; 0 = complete dependence, and 50 = full independence. The score can also be plotted on a “radar” chart, giving a pictorial representation of patients’ physical functions and highlighting the problem areas.[43] Corner et al. reported high content validity and limited ceiling and floor effects for CPAx in critical illness survivors. Lower CPAx scores are associated with mortality.[43] In an observational study, Corner et al. reported responsiveness of CPAx in measuring functional recovery in patients with acute severe burns.[44] Whelan et al. evaluated postsurgical patients and patients admitted to ICUs with traumatic injuries using CPAx. They reported that CPAx can be used as a part of physical therapy assessment to formulate problem-oriented rehabilitation resulting in improved levels of physical function, and that higher CPAx scores at admission are related to shorter hospital stays.[45]

O. Post COVID-19 Functional Status Score

The Post COVID-19 Functional Status Score (PCFS) was developed by Klok et al.[46] and emphasizes relevant aspects of daily life during follow-up after COVID-19 infection. The scale is ordinal, scoring from 0 (no symptoms) to 5 (death, D). It covers a vast range of functional outcomes by focusing on limitations in usual duties/activities either at home or at work/study, as well as changes in lifestyle. The scale scores are intuitive and can easily be grasped by both clinicians and patients. The PCFS is applied at different time intervals: time of discharge from the hospital, first weeks after discharge to monitor direct recovery (e.g., at four and eight weeks postdischarge, and six months after a COVID-19 diagnosis.[46] A recent study reported wide degrees of functional limitations in COVID-19 patients at hospital discharge and at six months follow-up assessed using the PCFS.[47]

P. Perme ICU Mobility Score

The Perme ICU Mobility Score was developed to measure a patient’s mobility status, commencing with the ability to follow commands and culminating in distance walked in two minutes. It includes 15 items in 7 categories: mental status, potential mobility barriers, functional strength, bed mobility, transfers, gait, and endurance. The scores range from 0 to 32, with higher scores indicating fewer potential mobility barriers and lower requirements for mobility assistance, and lower scores indicating more potential barriers and more assistance needed. Each of the 15 items is scored within the maximum range of 2–4. The total score that reflects the patient’s mobility status at one moment in time. Questions 1–8 require yes or no answers. For Questions 9–14, a score of 0 is assigned to patients who need total assistance (< 25% of the effort) or when the activity does not occur. A score of 3 is assigned to patients who need minimum assistance (> 75% of the effort) or when the activity requires supervision. Item 15 is scored from 0 to 3 based on the distance walked in two minutes. Perme et al. reported high validity and reliability and good clinical applicability. Kappa values for specific items were described with overall median agreement between raters of 94.29%.[48]

Timenetsky et al. assessed mobility in COVID-19 patients using the Perme Mobility Score, and identified low mobility in patients at ICU admission and improved mobility during the course of their stay.[49] Luna et al. reported minimal detectable change (MDC) for a Perme Mobility Score of 1.36 points, thus giving evidence of sensitivity to changes in mobility.[50] The tool is available in Spanish, Portuguese, and German. Psychometric properties of the translated versions have been established.[50,51,52]

IV. DISCUSSION

The ICU is a high-dependency zone, where patients present with severely compromised multisystemic dysfunction. An altered level of consciousness makes it difficult to evaluate physical function. Breathing difficulties, mechanical ventilators, pain, sedation, medication lines, catheters, and other devices further hinder mobility. Therefore, it becomes imperative to undertake a structured evaluation of pain and dysfunction in order to maximize functional recovery.

Very few reviews are available on the functional scales used in ICUs to evaluate physical function and pain. The scales need to demonstrate satisfactory psychometric properties in terms of internal reliability and validity, intertester reliability, and test-retest reliability in order to enable comparison between outcomes evaluated on a periodic basis to assess function. Clinicians need to be knowledgeable about available tools to enable identification of the right one based on specific patient needs.

In this narrative review, we have summarized the most commonly used scales that evaluate physical function of patients in the ICU, presented the strengths and weaknesses of each tool, and reviewed the studies that have validated the clinimetric properties of the scales in different patient populations. Despite the number of scales available, no single one addresses all clinical or research conditions. The tools have been developed over the decades to provide measures of patient activity, capacity, disability, and dependency.

Application of assessment tools is dependent on patients' level of functioning. Patients progress through complete dependency while unconscious, with poor ventilatory function requiring artificial ventilatory support, no spontaneous motor activity to gradually improving function (Fig. 1). Through the recovery trajectory, patients show linear improvement in neurological function, ventilatory function, voluntary activity, and physical function. Many of the scales are applicable through the complete functional trajectory while some can be used in the later phases of recovery. Each scale has its strengths and limitations. All scales included in this review along with application guidelines are freely available and therefore can be easily accessed and applied in practice by professionals. During the initial stages of recovery, scales such as the RASS, IMS-ICU, FSS-ICU, KPS, MRS, DRS, PRFS-ICU, and CPAx may be more applicable whereas greater objective assessment can be performed during later stages of recovery

LEVEL 0	LEVEL 1	LEVEL 2	LEVEL 3	LEVEL 4	LEVEL 5	LEVEL 6
Patient on artificial ventilation on CMV mode	**Change of ventilation mode (CMV to SIMV/ Spontaneous)**	**Patient off ventilator, extubated with or without O_2 support.**	**Patient conscious and oriented with or without O_2 support, either in ICU/ward**	**Patient conscious and oriented without O_2 support, either in ICU/ward**	**Patient fully co-operative, able to do major things actively, either in ICU/ward**	**Patient fully co-operative, able to do all things actively, medically stable, ready for discharge from ICU/ward**
Assessment scales: GCS: up to 3, RASS, IMS-ICU, FSS-ICU, KPS, MRS, DRS, CPAx	**Assessment scales:** GCS: >3 to 8, RASS, IMS-ICU, FSS-ICU, KPS, MRS, DRS, CPAx	**Assessment scales:** GCS: 9-12, RASS, IMS-ICU, FSS-ICU, KPS, MRS, DRS, PRFS-ICU, CPAx	**Assessment scales:** GCS: >12, RASS, BI/MBI, IMS-ICU, FSS-ICU, PFIT, KPS, MRS, DRS, PRFS-ICU, CPAx, PIMS	**Assessment scales:** GCS: >12, RASS, BI/MBI, IMS-ICU, FSS-ICU, PFIT, KPS, MRS, DRS, PRFS-ICU, CPAx, PIMS	**Assessment scales:** GCS: 15, RASS, RASS, BI/MBI, IMS-ICU, FSS-ICU, PFIT, KPS, MRS, DRS, PRFS-ICU, CPAx, PIMS, Katz Scale	**Assessment scales:** GCS: 15, RASS, BI/MBI, IMS-ICU, FSS-ICU, PFIT FIM, 4P, KPS, MRS, DRS, PRFS-ICU, CPAx, PIMS, Katz Scale, PCFS

FIG. 1: Applicability of scales based on level of functioning

using scales such as the FSS-ICU and PFIT. Typically, patients demonstrate a linear rise in function with higher scores on the functional scales.

The Barthel Index provides accurate results when used by both trained and untrained clinicians. It is a time-tested tool and can be reliably self-reported,[14] providing a quick assessment of self-care and mobility in patients with head injury and stroke. Good reliability has been observed with a change in two points reflecting change in patient status from dependent to independent. Collin et al.[14] reported that transfer and self-care items present challenges in reliable scoring and vary with observer skills. Variations in type of meal fed to patients create a difficulty in perceived difficulty in feeding. Ambiguity in dressing function led to modification of the tool. Further, observation of activities such as bathing and continence are time consuming, and patient input needs to be confirmed with nursing personnel. Thus, greater random error measurement and insensitivity to change due to scoring criteria make the modified Barthel Index a better measure of ADL.

The Modified Barthel Index with five-point scoring demonstrates better internal consistency than the Barthel Index in patients with stroke.[15] Yang et al. reported excellent test-retest reliability, lower randomized measurement error, and greater consistency in scoring than the modified Barthel Index.[16] Minimal detectable change (MDC), adjusted at 18.4% variation of the basal score was reported to be a better measure of actual change in functional status, and recommendations indicate that clinicians and researchers use MDC% adjusted scores to identify effects of novel therapies with greater accuracy. High interclass correlation coefficients with the Barthel Index are consistent among studies (ICC 0.94–0.99), indicating that either test can be used as a clinical measure.[9] Hsueh et al followed up a large cohort of stroke patients for six months and reported high internal consistency (alpha value 0.89–0.92) at different data points. In their observations, BI scores were well associated with scores of motor impairment on the Fugl-Meyer Motor Assessment Scale, the Berg Balance Scale, and the Frenchay Activities Index, which is a measure of instrumental activities of daily living. Thus, both the BI and the MBI emerge as strong tools with high convergent and predictive validity and satisfactory responsiveness in assessing ADL functions in stroke patients.[53]

The Functional Independence Measure has been used extensively in geriatric populations to identify functional impairments from a biopsychosocial perspective. Andrea et al. reported that low FIM scores were associated with higher 28-day, 90-day, and one-year mortality compared to high FIM scores.[18] The tool has also been used as a long-term predictor for measuring quality of life among patients with neurological disorders, demonstrating good reliability, validity, repeatability.[54] FIM has also been used in patients with chronic obstructive pulmonary disease (COPD) having difficulty in weaning from the ventilator.

The FSS-ICU appears to address the limitation of FIM as it includes detailed evaluation of graded ICU-applicable transfer activities, such as rolling in bed, supine-to-sit transfer, sitting at the edge of the bed, and sit-to-stand transfer. A major limitation of the FSS-ICU is that it does not take into account mental, cognitive, or social aspects of functioning. However, high inter-rater reliability makes it a useful tool for large multicentric trials.[55]

The physical function ICU test has been demonstrated to have good reliability and validity.[25] However, certain components such as spot-march may not be feasible in many patients in the ICU. Further, the walking ability of patients is not evaluated and a floor and ceiling effect may be observed. The PFIT scale was revised to delete certain components such as the shoulder lift in the PFIT-Scored version.[56] The scale displayed moderate convergent validity with the Timed "Up & Go" Test, and the Six-Minute Walk Test, was responsive to change and was predictive of key outcomes such as likelihood of discharge from the hospital, reduced length of hospital stay, and higher MRC scores.[56]

A recent study evaluated the inter-rater reliability of three physical function measures: the Physical Function ICU Test score, 30-second sit-to-stand repetitions, and Two-Minute Walk Test distance in an ICU setting. Low standard errors and good inter-rater reliability were observed between the three measures when used by trained clinicians, thus demonstrating the value of all three tools in assessing physical function in the ICU.[57]

Most tools are administered by clinicians, and the patient's perception of ability to perform physical functions remains unknown. The patient reported functional scale-ICU is a recently developed self-reported tool that measures patients' perception of their functional ability. The convergent validity of the PRFS-ICU has been tested against the FSS-ICU and the PFIT-Scored, and good correlation has been demonstrated.[58] Thus adding it to tools that can be administered following discharge to monitor long-term functional recovery.

The Karnofsky Index has been predominantly used in cancer survivors. It has demonstrated good correlation with the Katz activities of daily living (ADL) scale, and the basic activities of daily living (BADL).[30] However, it seems to be a less accurate scale of performance compared to tools such as the physical performance test.[59]

The disability rating scale is a commonly used outcome measure to assess impairment, disability, and handicap in neurological patients. A recent randomized controlled trail evaluated 508 patients with moderate to severe traumatic brain injury to identify the factor structure of DRS and its predictive validity. At one-year post-injury, the three disability items—feeding, toileting, and grooming—accounted for 58.4% of the variance; the three impairment items—eye opening, communication ability, and motor response—accounted for 14.8% of the variance; and the two handicap items—level of functioning and employability—accounted for 8.9% of the variance.[60]

The modified rankin scale (mRS) is used extensively in stroke patients. Its strength lies in its simplicity and coverage of functional outcomes ranging from no symptoms to death. Studies have demonstrated a strong correlation with outcome measures such as infarct volumes and good agreement with other stroke scales. However, the limited number of levels renders the scale less responsive to change in functional status, although a single-point change on the mRS has been shown to be clinically relevant.[61,62] Another limitation is score reproducibility. Therefore, further studies are warranted to explore the psychometric properties of the modified ranking scale.

Most recently, the COVID-19 pandemic has demonstrated that humans will continue to be challenged with new surging health conditions for which they may not be prepared. Novel clinical presentations may not be adequately addressed using existing tools, thus necessitating newer tools that can effectively examine functional status. The novel corona virus is known to bring about a strong immunological reaction leading to acute respiratory distress syndrome, inadequate ventilatory function, and lack of oxygenation, along with a myriad of other symptoms. This leads to the necessity of ICU admission in approximately 2% of COVID-19 patients. The post COVID-19 functional status score (PCFS) is one such tool, just formulated to evaluate functional recovery. However, further studies are needed to evaluate the tool's efficiency and psychometric properties.

Furthermore, early mobilization is a safe and feasible rehabilitation strategy that provides benefits in terms of reduced length of hospital stay, reduced days on mechanical ventilator, reduce bed rest complications, and improved ICU patient outcomes.[63] The Perme ICU Mobility Score measures the mobility of an ICU patient and also recognizes barriers to mobilization. Nawa et al. reported it to reliably assess mobility and to be an excellent candidate for further application in clinical and research setups.[64]

V. CONCLUSION

Evaluation of physical function provides invaluable information regarding functional abilities and can aid clinicians in providing structured care to facilitate rehabilitation. Key considerations in selecting the measurement scales are applicability, clinimetric properties, reproducibility, rehabilitation stage, functional domain, patient functional activity level, across rehabilitation, and need for ongoing evaluation.

VI. FUTURE IMPLICATIONS

The present study has provided a narrative overview of commonly used scales to assess physical function in the ICU. A systematic review is warranted to report evidence garnered by the various scales in specific patient populations to identify the most sensitive measures capable of identifying change in clinical status.

Future studies may be undertaken to administer these scales in a large patient population across various ICU settings and to examine their cross-cultural validity. Principal factor analysis and regression modeling may be used to identify key components related to other outcome variables in various disease conditions.

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