International Encyclopedia of Rehabilitation

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Functional Assessment

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Introduction

Functional assessment in medical rehabilitation is the objective measurement of the levels of a person's functional abilities in performing activities of daily living, including relevant psychosocial aspects. Assessment leads to appropriate interventions, so that a person can achieve the maximum possible functionality, toward a better quality of life. This chapter is in 6 sections, with the first 3 of more interest to clinicians, and the last 3 of more interest to researchers. The section titles with brief descriptions are:

- **Functional Assessment Tools** (select rehabilitation assessment tools)
- **The ICF Is Complementary to the LIFEware^SM System, FIM™ Instrument, and WeeFIM® Instrument** (tracking the functional health status of a low-back pain patient over time in several dimensions)
- **Monitoring Health Status and Function in Eldercare** (tracking the functional health status of a group of elders to determine best practices for desired outcomes)

- **Measuring Behavior and Outcomes to Achieve Evidence-Based Practice** (measurement of the latent traits that underlie functional performance)

- **Rasch Modeling and Assessment Instruments** (the principle of unidimensional, hierarchical, true measures)

- **Assessing Rehabilitation Program Effectiveness and Efficiency** (utility of the inpatient Program Evaluation Model)

The first section lists commonly used tools for functional assessment. The best tools are tested over time for their reliability, validity, responsiveness to change, feasibility for use, and meaningfulness in the clinical setting. Tools cover several domains, and are used for various populations and in numerous care settings. This is followed by 2 sections giving examples of the clinical use of outpatient assessment for monitoring functional and psychosocial status: for a patient with chronic low back pain, and in eldercare. Both cases are shown with functional deficiencies aligned with classifications of the International Classification of Functioning, Disability, and Health (ICF). Researchers will be interested in the last 3 sections. There is a section describing the application of the Rasch mathematical models to the development of assessment tools used in medical rehabilitation, so that observable behaviors are more accurately and objectively quantified. This is followed by a section on evidence-based practice, including the role of Rasch modeling, and a discussion on measuring outputs versus measuring outcomes and the differences between the biomedical model and the functional model. Finally, there is a section on aggregating and analyzing outcomes data from rehabilitation facilities so that their program effectiveness and efficiency can be assessed.

Functional Assessment Tools

Functional assessment involves gauging the performances of individuals on selected tasks within the context of specific physical and social circumstances. There are many tools and modes of testing available to describe and/or quantify the interactions among person skills, activity requirements, and environmental conditions. In other words, assessment tools range from those utilizing general, standardized protocols to those evaluating the unique, real-life daily challenges of a particular individual. The complexity of these assessment tools ranges from single domains to more global summaries of overall health and function, resulting in information across the different levels of functioning: impairments, limitations, and disabilities. Figure 1 contains select assessment tools from the rehabilitation literature, organized by functional domains, but does not contain a complete list. This compilation -- all of which have been translated into multiple languages -- demonstrates the breadth of reliable and valid assessment tools with regard to both narrow and overlapping domains of functioning as well as composite measures of integrative functioning. The common denominator of all domains listed is that they are deemed relevant to a person's ability to function and live independently or interdependently. It is important to note that test properties can vary considerably among different assessment tools designed to evaluate the same functional domains. Many tests, for instance, utilize a performance-based format, wherein a test administrator observes and records a person's performance on a standardized activity. Other tests use a self-assessment or patient-centered format, wherein a person describes his or her perceived ability to perform routine daily tasks in his or her real-world environment. In addition, the scales of measurement (nominal, ordinal, interval, or ratio level data) are not uniform across tests within the same functional domains. Thus, the process of test selection requires a clinician not only to match the purpose of the measurement or intervention with the functional domains of interest, but also to choose the most suitable test properties that best reflect the outcome's meaning and usefulness.

Figure 1. Select Rehabilitation Assessment Tools

Functional Domains	Tools
ADLs	**Barthel Index** (Mahoney and Barthel 1965) **FIM™ Instrument** (Uniform Data System for Medical Rehabilitation 1997) **Katz Index** (Katz et al. 1963) **LIFEware℠ System** (Baker et al. 1997)
Ambulation / Locomotion	**Dynamic Gait Index (DGI)** (Jonsdottir and Cattaneo 2007) **Functional Ambulation Profile (FAP)** (Nelson 1974) **Gait Abnormality Rating Scale (GARS)** (Wolfson et al. 1990) **Physical Performance Battery** (Guralnik et al. 1994) **Six Minute Walk** (Butland et al. 1982) **Timed Up & Go** (Podsiadlo and Richardson 1991) **Walking Speed** (Graham et al. 2008)
Balance	**Berg Balance Scale** (Berg et al. 1989) **Balance Self Perceptions Test** (Shumway-Cook et al. 1997) **Functional Reach Test** (Duncan et al. 1990)
Cognitive Functioning	**Mini-Mental State Exam (MMSE)** (Folstein at al. 1975)
Depression	**Beck Depression Inventory (BDI)** (Beck et al. 1988) **Center for Epidemiologic Studies Depression Scale (CES-D)** (Radloff 1977)
Executive Functioning	**Stroop Test** (Stroop 1935) **Trails A & B Tests** (Reitan 1955)
IADLs	**Everyday Problems Test (EPT)** (Willis et al. 1992) **Lawton Index** (Lawton and Brody 1969) **LIFEware℠ System** (Baker et al. 1997) **Pfeffer Index** (Pfeffer et al. 1982)
Memory	**Wechsler Memory Scale** (Tulsky and Ledbetter 2000)
Pain	**McGill Pain Questionnaire** (Melzack 1975) **Visual Analog Scale** (Revill et al. 1976)
Well-Being / HRQOL	**36-Item Short Form Health Survey (SF-36®)** (Ware and Sherbourne 1992) **Sickness Impact Profile (SIP)** (Bergner et al. 1981)

ADLs: activities of daily living; IADLs: instrumental activities of daily living; HRQOL: health-related quality of life.

The ICF Is Complementary to the LIFEware℠ System, FIM™ Instrument, and WeeFIM® Instrument

The ICF identifies disability and can assess degree of disablement, within the areas of body functions and structures, activities and participation, environmental factors, and personal factors, but it is not a disability measurement instrument or system. Functional assessment is an integral part of clinical rehabilitation medicine, guiding treatment types and duration, measuring treatment outcomes, estimating the burden of care that must be provided by others, and providing documentation for payment for care. However, the ICF structure with its classifications are complementary to the most widely used functional assessment instruments, all of which are offered to rehabilitation facilities on a subscription basis by the Uniform Data System for Medical Rehabilitation (UDSMR), Amherst, New York: the LIFEware℠ System (Baker et al. 1997) for adult outpatients; the FIM™ instrument (Uniform Data System for Medical Rehabilitation 1997) for adult inpatients; and the WeeFIM® instrument (Uniform Data System for Medical Rehabilitation 1998, 2002, 2004) for children.

The LIFEware℠ System measures function in adult outpatients in these domains: physical functioning, cognitive functioning, affective sense of well-being or mood state, experience with pain, community role, satisfaction with life, and satisfaction with treatment. The outpatient self-reports responses on LIFEware℠ System forms, which address specific problem areas, such as: musculoskeletal, neurological, cardiac, and pulmonary. Most often, the LIFEware℠ System assesses these domains: physical functioning (Body Movement and Control [BMC] measure of 10 items); affective sense of well-being or mood state (PLACID measure of 7 items); and experience with pain (PAINFREE measure of 6 items and the LIFEware® Visual Analog Scale [LVAS]). Subscribing facilities can customize forms for each outpatient by choosing from 30 measures. Items are rated on a scale of 0-100, with higher numbers representing better function.

The FIM™ instrument items cover these domains: self-care (eating, grooming, bathing, dressing upper body, dressing lower body, and toileting); sphincter control (bladder management and bowel management); transfers (bed/chair/wheelchair, toilet, and tub/shower); locomotion (walk/wheelchair and use of stairs); communication (comprehension and expression); and social cognition (social interaction, problem solving, and memory). Patients are rated by clinicians on all items at admission and discharge using a scale from 1-7, with 7 indicating complete independence, 1 indicating total assistance from a helper is needed, and the numbers in between representing various levels of patient dependence or independence. The totals of these numbers represent a patient's motor and cognitive functional levels, with a maximum possible total rating at 126, calculated from the 18 items multiplied by the most independent level of 7. A total rating of 18 indicates the lowest possible level of function. The WeeFIM® instrument for children assesses the same domains as the FIM™ instrument, and uses the same rating scale.

The UDSMR functional assessment *continuum of care* links adult inpatient and outpatient instruments and systems, with the rating scales adapted so that both the LIFEware℠ System and the FIM™ instrument report on a 0-100 scale, with 100 indicating better function. The resulting longitudinal records describe functional status across time and venues of care. The case example provided here shows a longitudinal record using the LIFEware℠ System. Also presented is a table showing items of the LIFEware℠ System related to this case, mapped to ICF classifications.

This case example (Figure 2) was a 25-year-old male, seen in an outpatient facility for a musculoskeletal condition, low back pain, as a result of injury while playing ice hockey. He had 6 visits over approximately 2 months. This longitudinal record, which appears here exactly as the clinicians would see it, shows the results of LIFEware℠ System functional assessments for each visit, for these measures: Body Movement and Control (BMC), LIFEware® Visual Analog Scale (LVAS), Painfree, Placid, Satisfaction (with life in general) and the Effort question (What is the most strenuous level of activity that you can do for at least 2 minutes?). Under each measure for each visit date, appear 2 types of information: rating totals (absolute ratings) for measures, in green, meaning they are above expected, or in red, meaning they are below expected. Also appearing are items under each measure that are problematic, with the minus signs showing how far they are below expected. (Items that are not problematic do not appear on the record.) Expected values are derived from thousands of cases in the database. Problematic items that appear on the record are addressed by clinicians. Each measure should be read from top to bottom (10/30/05 to 12/20/05) to determine, over time, gains (for BMC, VAS, Effort) or fluctuation (for Painfree, Placid, Satisfaction with life in general).

When seen at his first visit (10/30/05), the patient had absolute ratings that were all below expected (all in red), and numerous items under the measures appeared as problematic. The patient then was given pain and anti-inflammatory medications, heat therapy, and physical therapy. At the next visit (11/03/05), major functional improvement was indicated, with only 1 measure (Satisfaction with life in general) below expected, and the other measures above expected. At the next visit (11/06/05), there was a significant downturn, with all but 1 measure below expected. The clinicians would have needed to view the medical record to explain this change, which, in this case, was an event that caused a re-injury. The patient had been feeling better, moved furniture, and caused some of the initial problems to re-appear. Much of the same treatment was re-applied, and the patient was taught how to properly lift and build abdominal muscles. Over the next 3 visits, the patient showed functional improvement, and by the last visit (12/20/05), only the Satisfaction (with life in general) measure was below expected. Figure 3 shows all the LIFEware℠ System items that appeared on this patient’s longitudinal record, matched to ICF classifications. Only the question on Effort has no corresponding ICF code.

Another way of looking at the matching of the LIFEware® measures is within the structure of the ICF (Figure 4.) The ICF classifies health and health-related domains from body, individual, and societal perspectives, and contextual factors. This structure shows two divisions under ICF. Under Functioning & Disability, are the two branches of Body Function & Structure and Activities & Participation. Placed under these are the measures that relate to the case study. The other division shows Contextual Factors, under which are the branches of Environmental Factors and Personal Factors, and under these, the measures that relate to the case study.

Figure 2. LIFEware® Longitudinal Record, Case Example, Low Back Pain Patient

LIFEWARE® LONGITUDINAL RECORD OF FUNCTIONAL STATUS FOR CASE EXAMPLE
CONDITION: MUSCULOSKELETAL **PROBLEM:** LOW BACK PAIN
Patient code: xxxxxxxxx **Gender:** Male **Birth:** xx/xx/xx **Case open:** 2005
Subscriber: xxxxx **Marital:** Married **Onset:** N/A **Case close:** N/A
Employment: Employed **Living with:** Family **Clinicians:** xxx **Age:** 25 years

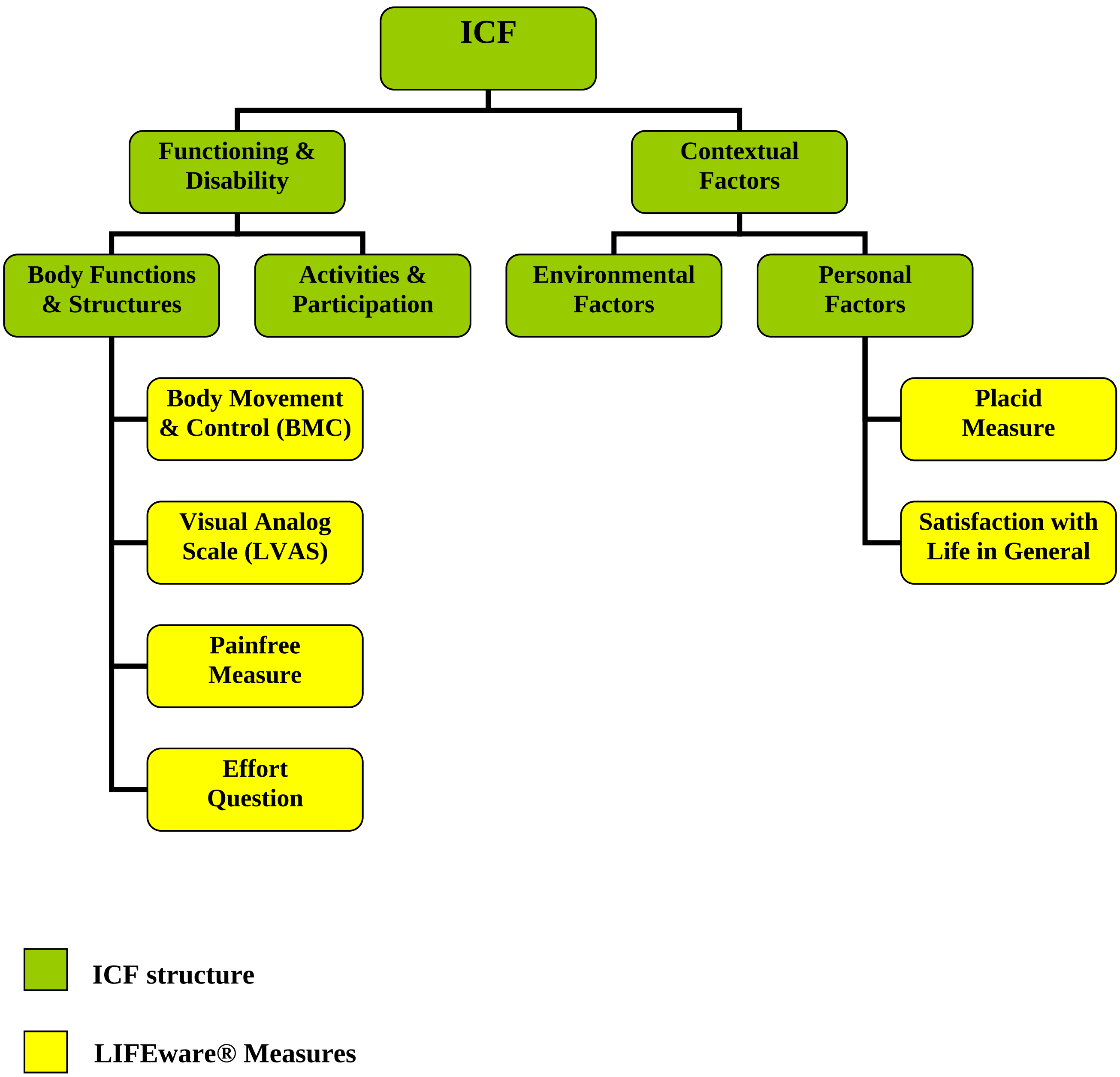
NOTE – Rasch Absolute Range is 0 to 100 (* indicates a secondary item not included in the calculation of absolute score)
Green = Above expected **Red = Below expected**

DATE	BMC	VAS	PAINFREE	PLACID	SATISFACT w/ LIFE	EFFORT
10/30/05	56 Absolute -41 Sitting -35 Stairs -35 Getting up -28 Standing -25 Kneeling -10 Reaching -3 Lifting	30 Absolute -21 Pain	49 Absolute -80 Burning -45 Splitting* -33 Throbbing -27 Sharp -18 Fearful* -18 Punishing* -15 Aching -12 Cramping* -3 Tiring	47 Absolute -40 Pessimistic -35 Morbid -32 Irritated -30 Uptight -30 Lonesome -21 Panic -15 Blame	35 Absolute -27 Life satisfaction	35 Absolute -16 Effort
11/03/05	83 Absolute -6 Sitting -3 Lifting	90 Absolute None below expected	95 Absolute None below expected	83 Absolute -15 Blame	60 Absolute -2 Life satisfaction	55 Absolute None below expected
11/06/05	33 Absolute -68 Stairs -58 Kneeling -51 Lifting -45 Reaching -44 Travel -41 Sitting -35 Getting up -30 Personal care -28 Standing	30 Absolute -21 Pain	39 Absolute -65 Sharp -45 Splitting* -42 Burning -33 Tiring -33 Throbbing -18 Punishing* -15 Aching	80 Absolute -21 Panic -12 Irritated	60 Absolute -2 Life satisfaction	2 Absolute -49 Effort
11/28/05	89 Absolute -6 Sitting -3 Lifting	90 Absolute None below expected	90 Absolute -3 Throbbing	76 Absolute -15 Blame -10 Lonesome -10 Uptight	35 Absolute -27 Life satisfaction	55 Absolute None below expected
12/08/05	86 Absolute -6 Sitting	90 Absolute None below expected	100 Absolute None below expected	74 Absolute -20 Pessimistic -15 Blame -12 Irritated -10 Uptight	35 Absolute -27 Life satisfaction	55 Absolute None below expected
12/20/05	95 Absolute -6 Sitting	90 Absolute None below expected	95 Absolute -3 Throbbing	80 Absolute -20 Pessimistic -10 Lonesome	60 Absolute -2 Life satisfaction	75 Absolute None below expected

Figure 3. LIFEware® Item Comparison With ICF Classifications, Case Example, Low Back Pain Patient

LIFEware® Item	ICF	ICF Description
Sitting for a long time, like for 30 minutes	Maintaining a sitting position (d4153)	Staying in a seated position, on a seat or floor, for some time as required, such as when sitting at a desk or table.
Climbing a flight of stairs	Climbing (d4551)	Moving the whole body upwards or downwards, over surfaces or objects, such as climbing steps, rocks, ladders or stairs, or other objects.
Getting up from a low seat like a sofa	Standing (d4104)	Getting into or out of a standing position or changing body position from standing to any other position, such as lying down or sitting down.
Standing a long time, like for 30 minutes	Maintaining a standing position (d4154)	Staying in a standing position for some time as required, such as when standing in a queue.
Kneeling or bending down to the floor	Kneeling (d4102) Bending (d4105)	Getting into and out of a position where the body is supported by the knees with legs bent, such as during prayers, or changing body position from kneeling to any other position, such as standing up. Tilting the back downwards or to the side, at the torso, such as in bowing or reaching down for an object.
Reaching and grasping something off a shelf at eye level	Reaching (d4452)	Using the hands and arms to extend outwards and touch and grasp something, such as when reaching across a table or desk for a book.
Lift	Lifting (d4300)	Raising up an object in order to move it from a lower to a higher level, such when lifting a glass from the table.
Travel	Recreation and leisure, other specified (d9208)	_ _ _
Personal care (washing and dressing)	Washing oneself (d510) Dressing (d540)	Washing and drying one's whole body, or body parts, using water and appropriate cleaning and drying materials or methods, such as bathing, showering, washing hands and feet, face and hair, and drying with a towel. Carrying out the coordinated actions and tasks of putting on and taking off clothes and footwear in sequence and in keeping with climatic and social conditions, such as by putting on, adjusting and removing shirts, blouses, pants, undergarments, saris, kimono, tights, hats, gloves, coats, shoes, boots, sandals and slippers.
Pain (VAS)	Sensation of pain (b280)	Sensation of unpleasant feeling indicating potential or actual damage to some body structure.
Painfree (hot-burning, splitting, throbbing, sharp, fearful, punishing-cruel, aching, cramping, tiring-exhausting)	Pain in body part, unspecified (b28019) Sensation of pain, other unspecified (b289)	_ _ _ _ _ _
Pessimistic about future	Optimism (b1265)	Mental functions that produce a personal disposition that is cheerful, buoyant, and hopeful, as contrasted to being downhearted, gloomy, and despairing.
Morbid or gloomy thoughts	Optimism (b1265)	Mental functions that produce a personal disposition that is cheerful, buoyant, and hopeful, as contrasted to being downhearted, gloomy, and despairing.
Easily irritated or annoyed	Psychic stability (b1263)	Mental functions that produce a personal disposition that is even-tempered, calm, and composed as contrasted to being irritable, worried, erratic, and moody.
Uptight, tense or stressed	Handling stress (d2401)	Carrying out simple or complex and coordinated actions to cope with pressure, emergencies, or stress associated with task performance.
Lonesome or isolated	Extraversion (b1260)	Mental functions that produce a personal disposition that is outgoing, sociable, and demonstrative, as contrasted to being shy, restricted, and inhibited.
Panic attacks	Regulation of emotion (b1521) Range of emotion (b1522)	Mental functions that control the experience and display of affect. Mental functions that produce the spectrum of experience of arousal of affect or feelings such as love, hate, anxiousness, sorrow, joy, fear, and anger.
Blaming yourself or guilt	Optimism (b1265) Confidence (1266) Temperament and personality functions, other specified (b1268)	Mental functions that produce a personal disposition that is cheerful, buoyant, and hopeful, as contrasted to being downhearted, gloomy, and despairing. Mental functions that produce a personal disposition that is self-assured, bold, and assertive, as contrasted to being timid, insecure, and self-effacing. _ _ _
Satisfaction with life in general	Temperament and personality functions, other specified (b1268)	_ _ _
Effort: What is the most strenuous level of activity that you can do for at least 2 minutes?	No corresponding code	_ _ _

Figure 4. LIFEware® Measures Mapped to the ICF Structure, Case Example, Low Back Pain Patient



Monitoring Health Status and Function in Eldercare

Best practices are achieved in eldercare by monitoring health status and function to:

- Support persons with chronic health conditions and/or disablement so that they may live in the community for as long as possible
- Achieve, maintain, and improve (when feasible) optimal quality of daily living, or delay an inevitable decline in functioning
- Identify at-risk situations and avoid preventable co-morbidities and hospitalization
- Defer long-term care institutionalization

Functional assessment is integral to the evaluation of the effectiveness of programs that assist seniors in remaining as independent as possible in many types of living situations: at home, with support from family and community-based organizations or with participation in adult day service programs or respite care; in subacute rehabilitation facilities, for short stays after surgery or illness; in adult homes or assisted living facilities; and in long-term care facilities.

Program evaluation in eldercare is generally a component of quality improvement. It involves the application of measures to groups of individuals for purposes of ongoing review in order to systematically resolve identified problems, pursue opportunities to improve care and services, and use evidence to support policy decisions.

Senior wellness programs emphasize improving the functional status of individuals through interdisciplinary interventions including fitness and exercise programs, nutrition counseling, physical therapy, occupational therapy, personal care assistance, leisure and recreational activities, socialization, psychological counseling, and spiritual counseling. The outcomes of interventions are determined by periodic reassessment of changes in the functional status of program participants over time. The purposes of measurement are to make explicit the outcome effectiveness, the efficiency, and the cost-effectiveness of the interventions. In this manner, the outcomes of wellness interventions may be described and monitored. Assessment of functional health is a method for describing a person's abilities and limitations. The essence of functional assessment is the measurement of a person's use of skills included in performing tasks necessary to daily living, leisure activities, vocational pursuits, social interactions, and other required behaviors. Measurement of functional abilities and outcomes must relate to real-life situations and settings. Longitudinal or follow-along evaluation of the physical and cognitive function of seniors, their ability to perform tasks relative to activities of daily living, and health events which may impair their ability for continuation in wellness programs may also be used to forecast their impending need for additional support services and/or alternate living situations.

Coordination of care and services for the frail elderly is one of the significant challenges of case management. Functional assessment and outcome measurement are important case management tools that facilitate communication among diverse health care providers, service organizations, and family caregivers who may have responsibility for various aspects of eldercare. A personal functional health record based on ongoing evaluation of the physical and cognitive function of a senior is a template for comparison of the person's progress or decline over time. Members of the caregiver team can compare the person's current functional status to that of the previous assessment and then make recommendations for changes in the number and/or type of interventions required to maximize independence. Periodic assessments assist in early identification of problems, such as changes in memory or mood that can be addressed promptly. Early identification of certain risk factors (e.g. increased difficulty with walking or eating) may prevent or delay transfer of a person to the next higher level of care, for example from an adult home to a long-term care facility.

The LIFEware℠ System (Baker et al. 1997) assessment has been successfully used to monitor the functional abilities of seniors across the continuum of eldercare (outpatient care, subacute rehabilitation, adult day service programs, and assisted living). For this population, the appropriate measures are physical and cognitive function, including the 18-item FIM™ instrument (Uniform Data System for Medical Rehabilitation 1997); and measures of memory, behavior, affect or mood, satisfaction with life, participation in social activities, physical limitations, pain level, anxiety, depression, and quality of sleep. Again, LIFEware® ratings are between 0 and 100 and higher numbers indicate better function; for most measures, 70 is the threshold of clinical significance, the academic equivalent of a passing grade. For example, in an adult home with a comprehensive wellness program, residents with lower ratings (below 70), in memory, motor function, and social level, were considered at risk for nursing home placement. Quarterly assessments of residents' functional status allowed the care team to introduce interventions that had the potential to prevent further decline and permit individual residents to age in place, in familiar surroundings with friends and staff with whom they were comfortable.

Figure 5. LIFEware® Longitudinal Record, Case Example, Eldercare Resident

LIFEWARE® LONGITUDINAL RECORD OF FUNCTIONAL STATUS FOR CASE EXAMPLE
CONDITION: Cardio-Pulmonary **PROBLEM:** A-fib, HTN, CAD, DJD, Psychosis, Hypothyroid
Patient code: xxxxxxxxx **Gender:** Female **Birth:** xx/xx/xx **Case open:** 2004
Subscriber: xxxxx **Marital:** Widowed **Onset:** N/A **Case close:** N/A
Employment: N/A **Living with:** N/A **Clinicians:** xxx **Age:** 86

NOTE – Rasch Absolute Range is 0 to 100 (* indicates a secondary item not included in the calculation of absolute score)
Green = Above expected **Red = Below expected**

DATE	FIMMOT	COGMEM	BEHAVIOR	LIMITATION	SATISFACT w/ LIFE	PLACID	COMMUNITY PARTIC/ SATISFACT
05/15/06	85 Absolute None below expected	43 Absolute -51 Objects -44 Social interaction -35 Times -21 Expression -20 Comprehension -19 Memory -8 Problem solving -7 Places	72 Absolute -66 Withdrawn -65 Agitation	88 Absolute -44 Vision -20 Bowel	100 Absolute None below expected	96 Absolute None below expected	Participation 100% Social Sleep 90% Sleep
08/29/06	86 Absolute None below expected	51 Absolute -51 Objects -35 Times -29 Social interaction -20 Comprehension -19 Memory -6 Expression	72 Absolute -66 Withdrawn -65 Agitation	Incomplete	100 Absolute None below expected	91 Absolute -10 Lonesome	Incomplete
11/07/06	86 Absolute None below expected	61 Absolute -35 Times -21 Expression -19 Social interaction -9 Memory -5 Comprehension	72 Absolute -66 Withdrawn -65 Agitation	Incomplete	100 Absolute None below expected	91 Absolute -10 Lonesome	Incomplete
02/08/07	85 Absolute None below expected	69 Absolute -21 Expression -20 Times -19 Social interaction -5 Comprehension	72 Absolute -66 Withdrawn -65 Agitation	Incomplete	100 Absolute None below expected	91 Absolute -10 Lonesome	Incomplete

The personal functional health record of a resident of an adult home specializing in eldercare is shown as Figure 5. The resident was evaluated using the LIFEware® assessment every 3 months as a component of the home's wholeness and wellness program. This woman, age 86 and widowed, entered the residence 2 years earlier, after the death of her husband. Her diagnoses were atrial fibrillation, hypertension, coronary artery disease, psychosis, hypothyroid, and degenerative joint disease. Initially she was withdrawn, hesitant to leave her room, and avoided eye contact. The wholeness and wellness staff members encouraged her to join in activities and utilized animal-assisted therapy, resulting in her turnaround that included becoming the greeter for visitors to the residence. The resident had excellent motor function throughout the assessment period and could perform most activities of daily living without the assistance of another person or a device (cane or walker). Her satisfaction with life was high (rated at 100) and her affective well being was very good (rated at above 90 at each evaluation). Her cognition improved from a rating of 43 (below the threshold for this function) to a rating of 69 (approximately at threshold value). Her memory was relatively poor at the time of her initial evaluation (rating of 43), but improved markedly at each subsequent evaluation. The absolute number in each column is the resident's total rating for that function or activity. Items listed below the absolute number are components of that particular measure that are less than expected values; the higher the negative number, the more significant the problem.

These LIFEware® assessment items correspond to ICF classifications. For example, in "COGMEM," a combination of memory and cognitive assessments, the most significant problem areas at the first evaluation were recall of objects (LIFEware® rating -51, ICF short-term memory b1440); and social interaction (LIFEware® rating -44; ICF basic interpersonal interactions d710, complex interpersonal interactions d720, and informal social relationships d750). These longitudinal functional health records were the bases for case management team conferences and facilitated tracking of outcomes of interventions focused on the resident's problem areas as well as her overall well being, in an objective manner. Future uses of the record include its incorporation into family conferences to keep loved ones apprised of the health status of the resident and the interventions being utilized to promote the resident's independence and quality of daily living.

Disablement is multidimensional, especially when combined with aging. Aging places individuals at risk for disability associated with poor health, reduced stamina, loss of loved ones, reduced financial reserves, and loss of options, choices, and autonomy. Reinforcement of the efforts of the caregiver team with a functional assessment system that is user-friendly and incorporates input from the senior as the focus of care maximizes efforts to retain independence. In the United States, there are increasing mandates for evaluation of eldercare programs that meet the goals of the baby-boomer generation to remain as independent as possible (preferably in their own homes) for as long as possible. Federal, state, and local organizations and programs that focus on seniors will be challenged to provide the most effective services possibly with more limited financial resources. A scientific approach to functional health assessment and outcomes analysis enhances the national dialogue for advancing evidence-based practices through the use of a common language for discussing these issues.

Measuring Behavior and Outcomes to Achieve Evidence-Based Practice

Measurement is the key to evidence-based practice (EBP). The primary premise of EBP is to define treatment options most likely to produce favorable clinical outcomes and, secondly, if the outcomes are expected to be similar, to be able to pursue the more cost-beneficial option of 2 or more treatment interventions. The primary goal of medical rehabilitation is to gain and maintain functional abilities for functional health. Functional status must be measured in order to conform to the expectations of evidence-based medical rehabilitation practice. Function is perceived differently depending upon the particular circumstances. Overall, in medical practice, functional abilities refer to biological, physical, psychological, social, and behavioral manifestations. Various combinations of functional circumstances often are referred to as quality of life or quality of daily living. Medical rehabilitation sometimes addresses specific aspects of functionality, while the ideal is to integrate the concept of multiple dimensions of function in order to define the whole person, but not to comingle dissimilar items within the same variable or measure.

It is important for clinicians to understand the characteristics of the tools used to assess function. Scaling of the tool may be nominal, ordinal, interval, or ratio. The properties of the variable help determine what methods of statistical analysis are appropriate for deriving inferences about functional outcomes. Tools may evaluate function directly or indirectly by addressing related characteristics. Indirect measurement requires selection of appropriate characteristics that represent the function(s) of interest. The tool should have proven validity and reliability in order to evaluate the targeted function. Functional abilities (meaning performing or achieving something useful) indicate that energy and/or information are being exchanged between 2 units (Tesio 2007). In biology, this exchange occurs between body parts: organs, cells, and molecules. When the units of the exchange are the person as a whole and the outer world (inclusive of other persons), the concepts of function and behavior may overlap (Tesio 2004, Tesio 2007) or function and activity may overlap (as per the ICF). Walking and breathing require that work using muscles be transmitted from the person to the ground and the air. Likewise, learning a language requires communication among people. Whatever the exchange, it has to do with the person as a whole, not with body parts (*I* walk and breathe, *you* are talking to *me*). Such a bidirectional flow (from/to the whole person) constitutes the inner mechanisms of a person's life, thus bringing to mind Dr. Carl V. Granger's motto: "As we function, so shall we live."

Biological functions are measured within a chemical-physical conceptual framework. Nerve conduction is observed through electronic devices that measure velocity; level of glycemia is measured in units of concentration in the blood; and heart work is measured in flow and pressure units. In each case, the gradient from less to more is spanned by continuous units that are linear: progressing from 2 to 3 means the same incremental amount as progressing from 1003 to 1004. However, when measuring person functional manifestations (variables or properties), the meaning of a *unit* is neither straightforward nor readily measured with a device, such as a ruler, gauge, or thermometer. The manifestations to be measured may be erroneously assumed to be representative of a unitary composite, but actually may be individually distinct properties, and vice versa. These phenomena of unpredictability of hidden person properties are known as *latent traits.* In a functional measure, as more of the component items are deemed to reveal the same underlying trait, then more of the trait of functional ability can be ascribed to the person. In using questionnaires, measurement begins by listing the items of interest and then counting them. However, raw counts (called *scores* or with some instruments *ratings*) derived in this way are only rough approximations of the true linear measures (Wright and Mok 2000). The list of items is arbitrary. The units represent unknown increments: *one more* may mean different changes of the latent trait, depending on the items; and higher counts may not mean *more* of the trait if they do not represent the same trait. It frequently happens that some items of interest do not *cooperate* consistently with the other items to form a calibrated measure. Thus, under these conditions, counting is mixing apples and oranges.

A formal solution to these critical flaws came from Rasch analysis (Andrich 1988) that allows transformation of raw scores into estimates of true linear measures, as shown in Figure 6. By using Rasch models, measures can be extracted from counts. Why would this be useful? Because a) good measures can reveal whether or not a treatment was effective, and b) measures help clinicians understand objectively whether and by how much effectiveness has increased or decreased. Within the domain of biomedical sciences, changes in a biological function are defined as *outputs*, whereas changes between 2 or more observations in a person's trait should be defined as *outcomes*. Regaining joint mobility in rheumatoid arthritis is an output. Reaching independence in dressing and walking is an outcome. Inferring outcomes from outputs is incorrect. The behaviors of dressing and walking come from high-order interactions between outputs and a person's latent traits. In this case, outputs are represented by increased mobility of previously stiff joints, whereas a person's latent traits may be tolerance to pain, motivation to walk outdoors, fear of falling, and memory and orientation. Hence, in traditional medical practice, with respect to disabling conditions, there is a gap between measuring outputs and measuring outcomes. The biomedical model has been dominant and has successfully elicited causal relationships across many chemical/physical phenomena, so that inferences are soundly established (lack of insulin leading to diabetes, antibiotic treatment leading to bacterial death). However, some predictions have been incorrect. In medical rehabilitation, ingenious orthoses that allow people with paraplegia to walk (output) often are abandoned within a few months because of cosmetic disappointment (outcome) or because moving around (outcome) is slower and more fatiguing, compared to wheelchair locomotion (Lotta et al. 1994). The need for accepting outcomes as a necessary indicator of effectiveness was emphasized by authoritative medical scientists such as Alvan R. Feinstein (Feinstein 1987). Yet much of medical research relies on rough counts (outputs) from questionnaires as a surrogate for outcome measures. Only recently, perhaps following increasing awareness of Rasch analysis, is the biomedical community acknowledging the need for better measures (Hobart et al. 2007), especially self-reported measures, rather than continued use of non-linear scales.

Improvement and maintenance of functional abilities (healthy functioning) is the prime goal of medical rehabilitation. Functional improvement should not be just an arbitrary change. Rather, functional gain should meet or exceed a pre-specified threshold of clinical significance. For example, improving leg function might not be of useful consequence if it does not lead to the ability to perform a transfer, stand, or walk. Achievement of transfers, standing, or walking are the clinically significant thresholds to be met for the treatment intervention to be considered useful and, therefore, successful. Thus, an aspect of successful medical rehabilitation is building and maintaining pre-specified thresholds of clinical importance.

Medical rehabilitation is rooted in biomedicine, yet it explicitly aims for behavioral results. Therefore, outcome measures should receive careful and persistent attention in construction, administration, and interpretation. Both sensitive and meaningful outcome measures are requisite for demonstrating effectiveness of rehabilitation treatment interventions, thus making them important for advancing the science of functional assessment and contributing to evidence-based practices of medical rehabilitation.

Rasch Modeling and Assessment Instruments

Rasch analysis, named for the Danish mathematician Georg Rasch (Rasch 1993), has been helpful to the field of rehabilitation medicine. Rasch analysis fosters the advancement of rehabilitation science by allowing objective measurement of subjective constructs. Rasch analysis has statistical models (formalized into equations) allowing for the transformation of questionnaire raw scores into objective equal-interval measures, such as those of length and weight. Behavioral sciences (rehabilitation, psychology) need quantitative assessment of constructs that cannot be observed directly (so-called *latent traits*), such as fatigue or pain.

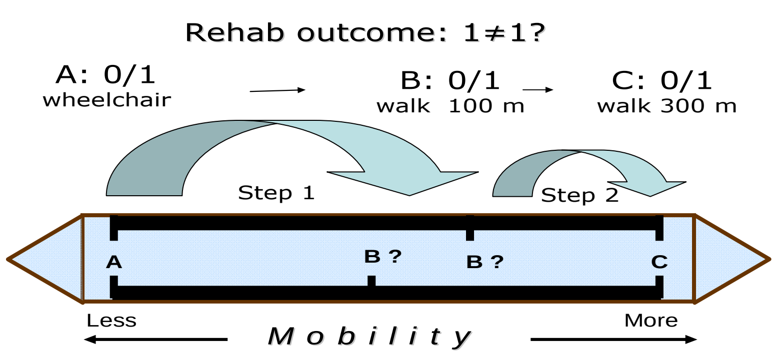
Conventional behavioral statistics is called *psychometrics,* though *person metrics* might be a more appropriate name. Measurement is based on questionnaires, often called instruments. Instruments are made of a set of observations (the items) deemed to represent a given trait or construct; a grading scale for the items, with numbers representing more or less of the variable (e.g. 0/1 = absent/present, 0/1/2 = no/mild/moderate); and summation of the item scores. The process is the same for self-reported and clinician-reported instruments.

Unfortunately, major flaws affect the use of raw scores:

- The cumulative score is bound between a minimum and a maximum, therefore it is more sensitive to a subject's scores in the mid-range, and is less sensitive at the lower and upper extremes. The floor effect places the score at the bottom end of the distribution because the task is difficult. The ceiling effect is the opposite, with participants at the high end of the distribution because the task is easy.

- The distances between scores are unknown, and 1 point may indicate different degrees of progress, depending on the unknown difficulty of the scale. See the example in Figure 6.

Figure 6. Diagram of 2 Rulers: Raw Scores and True Measures



> There is an illusion of linearity of raw scores. Imagine a question on mobility, assigning a score of 1 whenever 1 of 3 specific activities is performed. Intuitively, progressing from being in a wheelchair to walking 100 meters represents improvement in mobility much greater than the improvement from walking 100 meters to walking 300 meters. The ruler provides 2 series of demarcation: the lower assumes equal spacing; the upper gives the true measure of mobility, proportional to the difficulty represented by the various performances. Rasch analysis allows transformation of raw scores into true measures.

- The items that represent different traits, called *multi-dimensionality*, for example, education, income, and health status, cannot be summed in a quality- of-life questionnaire.

- The hierarchical profile of item ratings, showing their relative difficulties might not remain invariant with respect to extraneous subjects' properties. For instance, in a scale of independence in activities of daily living, the item called *eating* may be easier than the item called *grooming* for people eating with forks and spoons, while the reverse might be true for people eating with chopsticks. This phenomenon is called *differential item functioning.* It reveals that the trait depicted by the items is intrinsically different across classes of subjects. This characteristic of Rasch measurement must be appreciated.

- Rasch analysis is useful for determining an ordered rating scale, which is useful for the discrimination of categories. Without an ordered rating scale, it can be difficult to interpret raw scores and it may lead to unnecessary categories. Oftentimes researchers tend to believe that more scale categories increase the sensitivity of measurement. In actuality, for some users, more categories may just lead to confusion and difficulty in interpreting raw scores. Rasch analysis shows repeatedly that if categories are not labeled clearly or leave much to the imagination, then users often do not use them consistently and thus threaten the integrity of the measurement. Behavioral sciences (rehabilitation, psychology) need quantitative assessment of unobserved constructs, such as fatigue or pain.

In the measurement theory that Georg Rasch developed, the same axioms were held that underlie physical measurement. A fundamental property is the invariance of a given increment of the measure along the potentially infinite trait, which is called *local independence*. Also, the unit must be invariant across subjects, raters, and any other extraneous variables (objectivity). These together are the rationale for transforming counts of observations into units along the measurement continuum. Rasch framed these axioms into a probabilistic, not deterministic, perspective. He faced the issue of dichotomous items, where the observed outcome (or response) can only take the form of 1 of 2 alternatives. This implies that only certainty of the event (probability 1), or certainty of absence (probability 0) can be observed, no matter how the events are labeled (yes/no, agree/disagree, sometimes/never, 1/0, etc.). Such alternatives, however, are artificial because certainty in measuring latent traits is unattainable in the real world. One should think of probabilities along the continuum between 0 and 1, the so-called *expected score*. The difference (residual) between the observed and the expected scores represents the total error of the measurement. The residual includes a random error and a systematic error due to (often unknown) extraneous variables biasing the outcome toward 1 or 0.

The original dichotomous Rasch model evolved into various models encompassing both dichotomous and polytomous items (graded on more than 2 levels, e.g., 0/1/2, mild/moderate/severe) and the adjustment for systematic interferences (i.e., raters' biases, cross-cultural variances among persons, differential item functioning, etc.). Also, web-based item banks have been established, providing menus of items with calibrated difficulty, fostering both the comparisons across scores from different questionnaires or from different countries, and the construction of new questionnaires that comply with the strict Rasch model requirements.

Assessing Rehabilitation Program Effectiveness and Efficiency

The Institute of Medicine established aims for a 21st century health care system, stating that health care should be safe, effective, patient-centered, timely, efficient, and equitable (IOM 2001). Focusing on the aims of the institute, the UDSMR developed a Program Evaluation Model (PEM) to help its subscribing inpatient rehabilitation facilities (IRF) evaluate their performance, comparing them to other subscribing IRFs in the United States. The UDSMR aggregates IRF data on 5 outcome measures of acute rehabilitation into a PEM score that includes all patients who complete the course of rehabilitation. To understand the PEM, it is important to know that patient information is grouped, for insurance coverage purposes, according to patients' likely use of resources and likely lengths of stay. It is this case-mix designation group, called CMG (US Department of Health and Human Services 2002), plus other conditions, which determine the reimbursement to IRFs for Medicare Part A. (Medicare is part of the US Centers for Medicare & Medicaid Services, a government-funded insurance program. Medicare insures individuals with disabilities, individuals over age 65, and those with certain other illnesses.) Patients are assigned to 1 of 85 Impairment Group Codes, or IGCs (Uniform Data System for Medical Rehabilitation 1997), under 17 impairment groups. Each IGC falls into 1 of 21 general diagnostic categories called rehabilitation impairment categories, or RICs (Uniform Data System for Medical Rehabilitation 1997-2001).

The PEM is a case-mix and severity-adjusted model. This type of adjustment facilitates the monitoring of program performance on a periodic basis over time, while accounting for a population of patients with diverse impairments and varying levels of functional deficits and resource needs. On an aggregate basis, every program will have a unique actual and expected performance level for each outcome measure in the model. The PEM score represents a compilation of performance ratios (actual, relative to expected) across the 5 outcome measures. Measures selected for the PEM were taken directly from data routinely collected by IRFs using a standardized instrument called the Inpatient Rehabilitation Facility-Patient Assessment Instrument, or IRF-PAI (US Department of Health and Human Services 2002). This instrument contains the 18-item FIM™ instrument (Uniform Data System for Medical Rehabilitation 1997). The UDSMR collects about 900,000 IRF-PAI assessments a year from about 860 IRFs, nearly 70% of the total in the United States.

Of the 5 measures, 3 are case-level:

- Total Discharge FIM™ instrument rating (an indicator of rehabilitation effectiveness)

- FIM™ instrument rating change (degree of functional change between admission and discharge)

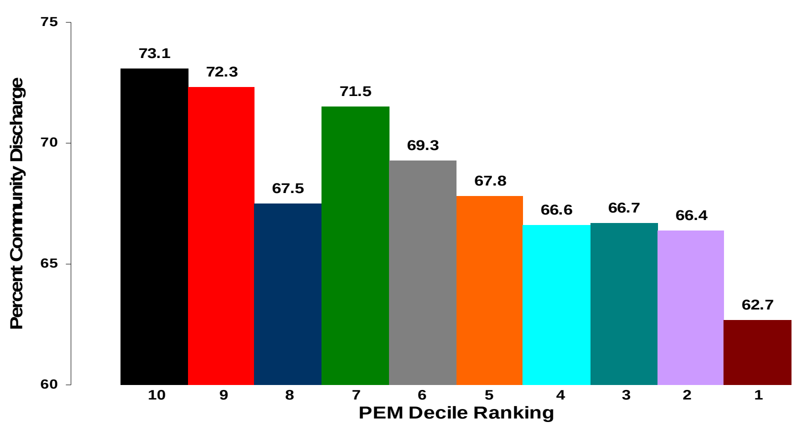
- Length of stay efficiency (an efficiency measure computed as FIM™ instrument rating change divided by length of stay in days)

The other 2 measures in the PEM are program-level measures associated with discharge destination:

- Rate of discharge to the community (Figure 7)

- Rate of discharge of cases back to the acute care facility before rehabilitation treatment is completed

Figure 7. UDSMR® Program Evaluation Model Results for Stroke Impairment and Discharge Disposition – Percent to Community by Decile Ranking



Results based on about 820 facility-level PEM reports, showing percents of stroke patients discharged to the community by decile ranking after inpatient rehabilitation for all qualifying rehabilitation hospitals in the UDSMR® database at one point in time. One of the goals of medical rehabilitation is to return patients to the community after treatment, so this is a way facilities monitor their program effectiveness.

Aggregated patient-level data also can be used to project patient function and discharge status. The AlphaFIM® instrument (Uniform Data System for Medical Rehabilitation 2005) was developed by the UDSMR to assess functional status in the acute care hospital and to provide a link to rehabilitation settings that use the 18-item FIM™ instrument, which assesses patient independence/dependence in rehabilitation settings. The AlphaFIM® instrument, a 6-item version of the FIM™ instrument, assesses independence and dependence in activities of daily living in the acute care hospital. The AlphaFIM® instrument was validated by using aggregate longitudinal stroke and lower extremity fracture case data from the UDSMR® database (Niewczyk et al. 2007, Granger et al. 2007, Granger et al. 2008). The AlphaFIM® instrument is administered within the first 72 hours of admission to acute care and at discharge, and has been shown to project patients' FIM™ instrument ratings at admission to an IRF, which could be the next placement for treatment.

The AlphaFIM® instrument's capability to project expected discharge status from the acute care setting can assist health care providers in post-acute care placement decisions, and functional status can be measured over time and settings. It has been found that the AlphaFIM® instrument correlated significantly with IRF discharge FIM™ instrument rating, r=.80; and IRF discharge FIM™ instrument rating correlated significantly with discharge placement, r=.59 (Niewczyk et al. 2007, Granger et al. 2007, Granger et al. 2008). In practice, when a patient is admitted to acute care, the AlphaFIM® instrument would be administered, and depending on this rating, the patient would be classified into a Functional Status at Discharge (FSaD) group. The FSaD group can be used to predict the patient's FIM™ instrument discharge rating, which can be used to estimate length of stay (LOS), LOS efficiency, and chances of returning to the community or back to acute care (Niewczyk et al. 2007). By using the AlphaFIM® instrument, clinicians can more accurately project a patient's rehabilitation prognosis in post-acute care venues.

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