Functional status measures for integrating medical and social care

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Abstract

Purpose: Identify standard self-report questions about functioning suitable for measuring disability across integrated health and social services.

Theory: Functional activities can be validly grouped according to the International Classification of Functioning, Disability and Health (ICF) chapters of mobility, self-care, and domestic life.

Methods: Cross-sectional analysis using information on 112,601 persons interviewed as part of the United States National Health Interview Survey on Disability. We combined related sets of questions and tested the appropriateness of their groupings through confirmatory factor analyses. Construct validity was addressed by seeking to confirm clinically logical relationships between the resulting functional scales and related health concepts, including number of physician contacts, number of bed days, perception of illness, and perception of disability.

Results: Internal consistency for the summed scales ranged from 0.78 to 0.92. Correlations between the functional scales and related concepts ranged from 0.12 to 0.52 in directions consistent with expectations.

Conclusions: Analyses supported the 3 ICF chapters.

Discussions: The routine collection of this core set of functions could enhance decision-making at the client, professional, organizational, and policy levels encouraging cooperation among the medical and social service sectors when caring for people with disabilities.

Keywords
disabled persons, integrated delivery system, computer communication health plan, computerized medical records systems, functional review of systems, international classification of functioning, disability and health (ICF)

Introduction

Health of the individual, or the population as a whole, is not just about the reduction of premature injury, morbidity or mortality [1]. It is also about human functioning and the capacity of the person to participate in society. Recognizing the need for a standard way to describe disability concepts in 2001 the World Health Organization established the International Classification of Functioning, Disability and Health, known as the ICF [2]. The ICF is intended to comple-
relevant information [5]. Our intent was to establish a core set of self-report measures of person-level functioning consistent with the ICF that would be sufficiently user friendly for routine collection by busy health care practitioners and social agencies.

Accepted by 191 countries, the ICF is fast becoming the international standard for describing health and disability. There are 2 broad classification categories— (1) Body Functions and Body Structures and (2) Activities and Participation—through which information is organized into chapters of related health concepts. All components within the ICF are quantified using the same generic scale which ranges from “no difficulty” through “complete difficulty.” This generic scale is presented as a means through which various assessment instruments can be calibrated [2]. Activity and Participation codes are organized into “Chapters” of related items. The ICF also includes environmental factors. These are known physical, social and attitudinal features surrounding the person that either hinder or facilitate potential for activity and participation.

The ICF, developed through the consensus of seven international WHO collaborating centres, is considered to be a classification scheme not a measurement system. The collaborative centres call for the “development of assessment instruments for identification and measurement” (p. 251) consistent with ICF concepts. The proposed core set of functions is presented as such an assessment instrument. The series of psychometric analyses to be presented here were necessary to provide evidence for validity of the proposed set of functional measures, and for the key ICF chapters they represent. Our method involves a confirmatory factor analysis applied to empirically test theoretically based constructs established through clinical logic and review of the literature.

Theoretical basis

The body function and structure components of the ICF reflect the types of information collected during routine medical review of systems. The core functions are being proposed as an analogous “functional” review of systems that are reflective of the Activity and Participation components. Mobility, self-care, and domestic life echo distinct well-established functional domains documented in the literature and were selected as the ICF chapters most fundamental to clinical objectives. Mobility includes motor functions (such as standing or reaching, etc.). These motor functions have been referred to as “functional limitations” and form the building blocks of more complex activities such as those included in the self-care and domestic life chapters [6]. Self-care describes basic “activities of daily living or ADLs”, such as dressing or toileting, and domestic life captures the more complex “instrumental activities of daily living”, such as shopping or heavy housework [8].

Within our conceptual framework these domains are partly hierarchical. Problems with mobility (the most basic functions) are primarily attributable to impairments in body function or structure, while difficulties with self-care or domestic life activities (the most complex) depend on interactions between those impairments and environmental barriers [9]. Figure 1 illustrates this conceptual framework with the core functions arranged by chapter as supported by the analyses described below. Widespread collection of responses to this core set of functions could aid clinicians and policy makers to make health care more responsive to the needs of individuals. It could improve the support of populations of people with disabilities by encouraging better linkage of health to social care services.

Methods

Data

The core set of functions was developed from questions on the 1994–1995 disability supplement of the National Health Interview Survey on Disability (NHIS-D) [10, 11], originally intended to reflect the World Health Organization’s International Classification of Impairment, Disabilities and Handicaps [12] that preceded the ICF. The NHIS-D is a cross-sectional, stratified, random, multi-staged probability sample representative of the United States (US) non-institutionalized population. We selected respondents 18 years of age and older (n=143,007). A random selection of 80% of the data was used (n=116,005). The remaining data were held back for cross validation of multi-variate statistical models applying the core set of functions in subsequent analyses not presented here.

NHIS-D questions

The NHIS-D questionnaire obtained information about all members of households selected at random to be representative of the non-institutionalized population. It included questions about abilities to perform 20 routine activities rated as: (1) “no difficulty”, (2) “some difficulty”, (3) “a lot of difficulty”, and (4) “completely unable”. Related questions were grouped according to the content of known measures into mobility, self-care and domestic life scales [6–8], the mobility chapter was anticipated to have 2 domains [13].
expressing primarily lower body and upper body functions.

**Factor analysis**

We applied confirmatory factor analyses in order to empirically test the validity of the theoretical constructs described above. The factor analysis was to be considered successful in validating the hypothesized theoretical model if there was a clear clinical interpretation consistent with expectation for each identified latent factor. Sample weights were used to account for the multistage sampling design. Analyses began assessing the number of underlying latent dimensions necessary to adequately explain correlations among observed item scores. This was done by constructing a Scree plot of the incremental magnitudes of the eigenvalues determined from the correlation matrix versus their rank order. The cumulative sum of eigenvalues divided by the number of items reflects the total variance explained by that number of latent dimensions among the multiple items. The point where the incremental addition of another factor does not appreciably increase this variance indicates that the data do not support further increase in latent dimensionality. We hypothesized that the 20 NHIS-D questions arose from the 4 latent domains expressed above. We further hypothesized correlations between the self-care and domestic life domains to be at least moderate. Therefore, the factor analytic model was determined after promax oblique factor rotation which allows for inter correlation among the factors. In general, the quality of a factor analytic solution is judged on the simplicity of the factor pattern matrix. The factor pattern matrix summarizes the magnitude of the associations between observed measures and underlying latent traits. A simple solution is one in which items tend to be highly associated with only one latent dimension. The objective of factor rotations is to select among the optimal factor pattern matrices, the one that has the simplest structure according to some criterion for ‘simplicity’. Dimension-specific indices were constructed as sum scores from items with factor loading that were greater than 0.40. Factor solutions were obtained using SAS software version 8 [14].

**Summed scale analysis and item-total correlations**

Cronbach’s alpha [15] was used to measure the internal consistency of the constructed sum score scales [16] and to study the effect of deleting the item
with the lowest item-total correlations. If removal significantly increased alpha, the item was excluded because its presence detracted from the internal consistency of the constructed sum score index.

**Establishing population norms for the scales**

The United States population is used to illustrate the process of establishing norms. The number of individuals per 10,000 in the United States who had at least some difficulty with one or more activities in each domain was determined using population weighted data. To calculate confidence limits, the standard error of estimated prevalence values were computed, taking into account the multi-stage sampling design through SUDAAN [17]. As a last step in scale development we translated mean index scores estimated from the 4-level NHIS-D items into 5-category ordinal scales consistent with the 5-level ICF paradigm. This 5-level scale reflects the ICF qualifiers of: no difficulty in any of the items (all scores by definition, were 1), mild difficulty (mean item score ranged from 1 to \( \leq 1.5 \)), moderate difficulty (mean item score ranged from 1.5 to \( \leq 2.5 \)), severe difficulty (mean item score ranged from 2.5 to \( \leq 3.5 \)), and complete difficulty (mean item score ranged from 3.5 to \( \leq 4.0 \)).

**Validity**

Construct validity of the scales was determined by testing for expected associations with other NHIS-D questions [10, 11] using Spearman rank correlations. The largest associations of the functional scores were expected with perception of disability. Smaller associations were expected with the numbers of physician contacts and the number of days the individual remained in bed at least half the day over the last year.

**Results**

There were 112, 601 subjects whose data were complete in all 20 activities used to form the scales. Over half (53.4%) were women, 56.4% were between the ages of 18 and 44 years, and 6.2% were over 75 years of age. Just under 2/3 of respondents were described as white. Table 1 characterizes the actual respondents included in this study, and shows the proportion of the population represented by each characteristic.

**Item level analyses**

Eating was the activity in which the fewest reported problems and walking 1/4 mile was the activity in which the largest number reported problems. At least some individuals were coded as functioning at each level in each of the 20 items.

**Table 1. Characteristics of the sample with weighted crude proportion of cases used to establish the core set of functions**

| Variables | Number* | Percent Actual | Percent Weighted |
|-----------|---------|----------------|------------------|
| Gender    |         |                |                  |
| Female    | 60111   | 53.4           | 52.0             |
| Male      | 52490   | 46.6           | 48.0             |
| Race      |         |                |                  |
| White     | 79602   | 71.0           | 75.0             |
| Black     | 13145   | 11.7           | 10.9             |
| Hispanic  | 14630   | 13.0           | 9.5              |
| Other     | 4724    | 4.2            | 4.6              |
| Age       |         |                |                  |
| 18–44     | 63453   | 56.4           | 57.8             |
| 45–64     | 31009   | 27.5           | 26.7             |
| 65–69     | 5897    | 5.2            | 5.0              |
| 70–74     | 5211    | 4.6            | 4.4              |
| 75 and older | 7031 | 6.2            | 6.1              |

* Numbers of actual respondents used in building the functional indices are shown for each characteristic. Note: Race was missing from 500 cases.

**Factor analysis**

The Scree plot of eigenvalues identified a 4-factor solution as optimum. These first 4 eigenvalues summed to 70% of the total sum of the eigenvalues. The rotated factor pattern is shown in Table 2, supporting the 3 ICF chapters of mobility (factors 1 and 4), self care (factor 2) and domestic life (factor 3), with the mobility chapter further sub-divided into lower (factor 2) and upper body scales (factor 4), as expected. Review of the factor loadings of items associated with each factor shows all expected items met the minimum 0.40 criterion for belonging to their expected latent dimension. For example, loadings for the first factor ranged from 0.65 to 0.87. In contrast, factor loadings for those items identified as associated with factor 1 were close to zero with one exception. The factor 3 loading for “heavy house work” was 0.39, although still below the 0.40 criteria. This implies that this activity is multidimensionally associated with factor 3 as well as with factor 1. This activity hypothesized to be associated with items in the domestic life chapter (factor 3), was associated more strongly with lower body functions (factor 1). The “reaching” activity in upper body functions loaded weakly compared to the other activities in the upper body function (factor 4) domain. All other items loaded on the factors expected.

As anticipated, the largest inter-factor correlation was between self-care and domestic life, at 0.54. The next
Table 2. Rotated factor matrix—describes how each item loads on the underlying dimensions as named—and summary of item total correlations and Cronbach alphas after deletion of each variable

| Activity                      | Factors | Correlation with Total | Alpha after item removal |
|-------------------------------|---------|------------------------|--------------------------|
|                               | 1       | 2                      | 3                       | 4                       |
| **Factor 1**                  |         |                        |                         |                         |
| Walking a quarter mile        | 0.869   | -0.023                 | -0.024                  | -0.003                  |
| Walking up 10 steps           | 0.821   | 0.070                  | -0.040                  | 0.013                   |
| Standing 20 minutes           | 0.809   | 0.064                  | -0.065                  | 0.031                   |
| Bending from standing         | 0.758   | 0.096                  | -0.109                  | 0.100                   |
| Lifting 10 pounds             | 0.703   | 0.001                  | 0.040                   | 0.121                   |
| Doing heavy housework*        | 0.649   | -0.171                 | 0.389                   | -0.025                  |
| **Factor 2**                  |         |                        |                         |                         |
| Getting in and out of bed or chairs | 0.020 | 0.923                  | -0.032                  | -0.045                  |
| Using toilet                  | 0.060   | 0.920                  | -0.063                  | -0.012                  |
| Getting around home           | 0.085   | 0.890                  | -0.052                  | -0.052                  |
| Dressing                      | 0.017   | 0.782                  | 0.013                   | 0.029                   |
| Eating                        | -0.236  | 0.829                  | 0.199                   | 0.246                   |
| Bathing                       | 0.171   | 0.626                  | 0.205                   | -0.049                  |
| **Factor 3**                  |         |                        |                         |                         |
| Managing money                | -0.078  | -0.059                 | 0.909                   | 0.026                   |
| Using telephone               | -0.229  | 0.110                  | 0.767                   | 0.133                   |
| Preparing meals               | 0.086   | 0.186                  | 0.734                   | -0.045                  |
| Shopping                      | 0.330   | -0.012                 | 0.703                   | -0.081                  |
| Doing light housework         | 0.332   | 0.196                  | 0.502                   | -0.071                  |
| **Factor 4**                  |         |                        |                         |                         |
| Using fingers for grasping    | 0.115   | -0.032                 | -0.004                  | 0.845                   |
| Holding pen/pencil            | 0.028   | 0.029                  | 0.051                   | 0.835                   |
| Reaching*                     | 0.373   | 0.014                  | -0.045                  | 0.457                   |

* Item removed from factor to create final scale.

largest were between lower body and self-care and lower body and domestic life, 0.46 and 0.42, respectively. The remaining inter-factor correlations were less than 0.33.

Excluding shared variance, the percentages of variance explained by the lower body, self-care, domestic life, and upper body domains were 14.9%, 12.6%, 10.0%, and 7.7%, respectively. Including shared variance, the percentages of variance explained by these same factors were 32.4%, 34.4%, 29.1%, and 18.8%, respectively. The final communality estimates of items ranged from 44% for reaching to 83% for getting in and out of beds and chairs. The communality of a variable is the percentage of variance in an observed variable explained by the latent factors.

**Internal consistency of constructed scales**

Cronbach’s alpha (internal consistency) was 0.89, 0.92, 0.69, and 0.97, for the lower body, self-care, upper body, and domestic life scales, respectively. As noted above, a single item, heavy housework, did not appear to fit its anticipated construct. Expected to load most heavily on domestic life, it loaded slightly more heavily on lower body functions. Tested with both constructs, heavy housework had the lowest item-total correlations of all items. It was removed after documenting that its inclusion reduced internal consistency of the domestic life and failed to improve internal consistency of the lower body scale. This is important because it suggests that heavy housework, although occupationally related to light housework, is different from the other items currently included in either scale.

Although difficulty reaching met the 0.40 loading criterion necessary for inclusion in the hand and arm use scale, it had the lowest item-total correlation. Internal consistency of items in the upper body use scale increased from 0.69 to 0.78 after it was excluded. Although unexpected, this improvement in internal consistency with the removal of reaching makes sense clinically. Certainly hand and arm function are physiologically and anatomically distinct. The reaching and heavy housework variables were removed from the scales but included in subsequent analyses as separate indicators of arm use and heavier domestic life activities, respectively. Alphas were stable for the other scales when the lowest correlating item was removed. Consequently, the core set of functions yields 3 chapters expressing mobility, self-care, and domestic life activities. Mobility sub-divides into lower
Table 3. The ICF core functions

| Table 3. The ICF core functions | 1. No difficulty | 2. Some difficulty | 3. A lot of difficulty | 4. Completely unable | 5. Do not know |
|---------------------------------|-----------------|-------------------|-----------------------|---------------------|---------------|
| Mobility: Lower body            |                 |                   |                       |                     |               |
| Walking one quarter-mile        | ○               | ○                 | ○                     | ○                   | ○             |
| Walking up 10 steps             | ○               | ○                 | ○                     | ○                   | ○             |
| Standing 20 minutes             | ○               | ○                 | ○                     | ○                   | ○             |
| Lifting 10 pounds               | ○               | ○                 | ○                     | ○                   | ○             |
| Bending down from a standing position to pick up an object from the floor | ○ | ○ | ○ | ○ | ○ |
| Mobility: Hand use              |                 |                   |                       |                     |               |
| Grasp handle                    | ○               | ○                 | ○                     | ○                   | ○             |
| Hold pen                        | ○               | ○                 | ○                     | ○                   | ○             |
| Mobility: Arm use               |                 |                   |                       |                     |               |
| Reaching                        | ○               | ○                 | ○                     | ○                   | ○             |
| Self-care                       |                 |                   |                       |                     |               |
| Getting to and using toilet     | ○               | ○                 | ○                     | ○                   | ○             |
| Getting in and out of chairs/bed| ○               | ○                 | ○                     | ○                   | ○             |
| Moving inside home              | ○               | ○                 | ○                     | ○                   | ○             |
| Dressing                        | ○               | ○                 | ○                     | ○                   | ○             |
| Eating                          | ○               | ○                 | ○                     | ○                   | ○             |
| Bathing or showering            | ○               | ○                 | ○                     | ○                   | ○             |
| Domestic life—Light             |                 |                   |                       |                     |               |
| Managing money                  | ○               | ○                 | ○                     | ○                   | ○             |
| Preparing meals                 | ○               | ○                 | ○                     | ○                   | ○             |
| Shopping                        | ○               | ○                 | ○                     | ○                   | ○             |
| Light housework                 | ○               | ○                 | ○                     | ○                   | ○             |
| Domestic life—Heavy             |                 |                   |                       |                     |               |
| Heavy housework                 | ○               | ○                 | ○                     | ○                   | ○             |

body, hand use, and arm use. Self-care includes a single ADL scale. Domestic life divides into lighter and heavier instrumental activities of daily living. The final alphas were 0.89, 0.78, 0.92, and 0.87 for the lower body functional limitation, the upper body functional limitation, self care scales, and domestic life scales, respectively. These findings support the conceptual framework of measurement as diagrammed in Figure 1.

These concepts are organized by ICF Chapter into a simple self-report checklist that can be applied in the clinic (Table 3).

Validity

Construct validity was supported by Spearman rank correlations between the functional limitation scores and perceived disability, ranging from 0.27 to 0.52; for bed days, from 0.10 to 0.20; for number of physician contacts, from 0.12 to 0.20; and for perceived health status, from 0.15 to 0.35. The generally larger correlations with the perceived disability construct were taken as evidence for construct validity.

Table 4 estimates the United States population prevalence (per 10,000 persons) expected to have at least some difficulty performing one or more of the activities in each domain or chapter based on population weighted data. Problems with lower body functioning appear by far the most prevalent and self-care limitations the least.

Discussion

Results of our factor analyses support the core set of functional measures organized into the mobility, self-care, and domestic life chapters bridging population level NHIS variables from the US with ICF concepts. By facilitating standard comparisons for clinical practice and program evaluation, we propose that this standard set of core functions can help link and coordinate care across general practitioners, rehabilitation professionals, and social services as well as acute and long term care sectors. The component scales appear to reflect distinct clinically relevant concepts that correlate expectedly with perceived disability, perceived illness, greater numbers of bed days, and increased physician utilization in the US supporting construct validity. The core set of functions are sufficiently parsimonious for acquisition during routine clinical encounters through patient self-report or proxy.
### Table 4. Applying the core functions to show patterns of disability in a population

| Scale                     | Prevalence estimate | 95% Confidence Interval |
|---------------------------|---------------------|-------------------------|
| Lower body functional limitation | 1025                | 999–1051                |
| Reaching over head or out  | 215                 | 204–225                 |
| Hand use                  | 229                 | 218–240                 |
| Self-care (ADL)           | 135                 | 127–143                 |
| Domestic life (IADL)      | 216                 | 205–227                 |
| Heavy housework           | 394                 | 377–412                 |

Appropriate use could express the effects of illnesses, injuries and interventions on life participation in ways that are meaningful to patients [18] and facilitate communication among the many professionals and organizations necessary in providing care to patients with disabilities and multiple needs. Once collected, the core functions could be disseminated through electronic formats across settings [19] and applied in multi-level analyses (Figure 2). Uploads from the medical clinic to administrative databases with linkage to diagnostic information could enable population surveillance at the health plan, regional, and national levels. Such an “information highway” for centralizing medical and functional status information [20] has already been proposed by the Canadian government. All public, private, or voluntary health and social service organizations in an area could agree to participate in an umbrella system in efforts to enhance the coordination and efficiency of care for patients with multiple needs, while maintaining their own structures [21].

The core set of functions might serve as a functional review of systems and routine screen for frailty. Physicians typically overlook the disabilities perceived by their patients [21]. Disability is associated with reduced use of preventive services, such as mammograms [22, 23], the tendency to diagnose cancer at later stages [24], and elevated risks of institutionalization and mortality [5, 25–28]. Specific interventions to help older people maintain independent functioning have shown benefits across multiple health, function, and quality of life domains [29–31].

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**Figure 2.** The proposed functional information infrastructure.
Program evaluators and clinicians in integrated settings have long struggled with applicability of normative data across populations. The routine collection of these core functions during patient encounters could prove important to both program evaluators and clinicians. It could provide a meaningful first step towards obtaining normative data about disabilities across populations for integrated service planning purposes. Although people with disabilities comprise only about 1/6 of the population in the US, they account for almost half of all medical spending [32]. Measures of function are used in determining national payment rates for long-term care [33], rehabilitation [34], and home care services [35, 36]; in addressing best practices among large health systems [37, 38]; and in monitoring population health goals regionally and nationally [39]. Each application uses different measures, hindering integration of objectives, blocking the integration of health and social services and potentially leading to duplication of efforts across venues or programs of care. Seeing this as problematic, the Benefits Improvement Act of 2001, supported by the U.S. Medicare Payment Advisory Commission [40], mandated development of standard scales for assessing the health and functioning of patients across all post-acute settings [41]. Additionally, a joint report by the U.S. Department of Health and Human Services and the Centres for Disease Control [42] called for projects to demonstrate the inclusion of functional status data in standardized electronic patient records, claims forms, and encounter forms, acclaiming the ICF as the most promising approach to standard measurement. The heterogeneity of patients served across care venues makes the identification of a parsimonious set of questions challenging.

The core functions were selected to be consistent with ICF concepts and to bridge content across measures typically applied in the acute [42, 43], rehabilitative [44], and long-term care settings [45]. Isolated difficulty with heavy housework and shopping will identify people with milder disabilities, while problems using the toilet and eating will identify those with more severe disabilities. Reliability of the core functional scales was consistent with commonly used health status instruments [46–50]. The core set is not intended to replace the more detailed setting- or condition-specific instruments but rather to offer global indicators appropriate to linking and transmitting information across venues.

We end with several cautionary notes. Specific to each health system and nation, demonstrations will be needed to determine appropriateness of these measures to the proposed applications. We caution that it may not be reasonable to hold health care systems responsible for the functional deterioration of individual patients. While the linking of individuals’ self-report functional status information to administrative databases could provide a “powerful window” for showing the effectiveness of the health care system [51], use of such information has implications with regard to protecting individual privacy [52] and could be applied by payers to exclude populations of people whose disabilities (they believe) will likely cause high future expenditures. Ongoing debate is necessary on whether the value of collecting this type of information and enabling its reuse for administrative and policy purposes outweighs the potential economical and non-economical costs of collection.

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