

RESOURCE DOCUMENT

MED-AUDIT Impairment Categories: Working towards Mapping AMI Usability

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Executive Summary

Access to health care is often challenging, even prohibitive, to people with disabilities. A burgeoning elderly population is adding to this disserved public. Inaccessible medical instrumentation is a fundamental barrier to health care employees and consumers with disabilities. The Rehabilitation Engineering Research Center on Accessible Medical Instrumentation (RERC-AMI) is designing Medical Equipment and Device Accessibility and Universal Design Information Tool (MED-AUDIT) to assess the usability of medical instrumentation for people with disabilities. As part of this process, the measurement parameters of an impairment categorization scheme (consistent conceptual definitions, mutually exclusive, comprehensive) are discussed and will provide a dimension to MED-AUDIT. Examples of existing impairment-related categorization schemes, formed for a variety of purposes, are reviewed and the measurement parameters for the MED-AUDIT impairment categorization scheme are discussed. Finally, a tentative RERC-AMI MED-AUDIT impairment categorization scheme is presented.

Background

According to the U.S. Department of Health and Human Services (July 2004), 205,825,000 people 18 years of age and older in the United States had found at least one of nine basic physical activities “very difficult” to perform or “can’t do at all.” This statistic reveals a challenge to the health care system; specifically designers, manufacturers, and consumers of medical instrumentation. Millions of people with some level of physical disability require usable medical instrumentation, both as employees and consumers. MED-AUDIT addresses this challenge by beginning with a list of specific impairment categories, matching those to tasks and medical device features, and finally analyzing the medical device usability for specific impairments.

Measurement Parameters

The initial measurement parameters of the RERC-AMI MED-AUDIT impairment scheme are that the categories have consistent conceptual definitions, are mutually exclusive, and are comprehensive.

Consistent Conceptual Definitions

The words ‘disability,’ ‘impairment,’ ‘condition,’ and ‘functional limitation’ are often used in literature and society as having equivalent meaning. For example, a person may have the condition of Muscular Dystrophy, resulting lower extremity impairment, the ensuing functional limitation of not being able to walk or stand for a substantial distance or length of time, and this person may be socially and politically considered as having a disability. A clear and distinct

definition of ‘impairment’ is necessary for mapping impairments to tasks to medical instrumentation. Interchanging the conceptual definition of the category inhibits mutually exclusive categories (discussed further in the next section).

For the purposes of the RERC-AMI MED-AUDIT, the conceptual definition of ‘impairment’ is taken from the *1980 World Health Organization’s International Classification of Impairments, Disability and Handicaps* (Barbotte, E., Guillemin, F., Chau, N., & the Lorhandicap Group, 2001):

Any temporary or permanent loss or abnormality of a body structure or function, whether physiological or psychological. An impairment is a disturbance affecting functions that are essentially mental (memory, consciousness) or sensory, internal organs (heart, kidney), the head, the trunk, or the limbs.

To further refine the definition for the purpose of the RERC-AMI MED-AUDIT, the temporary or permanent loss or abnormality of a body structure or function must have the potential of impeding a task required to use medical instrumentation.

This clear definition of impairment, used consistently, increases the reliability and validity of the measurement tool by allowing a definitive classification for multiple users across time.

Mutually Exclusive

Mutually exclusive means that each impairment must have only one category. Table 1 illustrates categories that are and are not mutually exclusive.

Table 1: Mutually exclusive categories and not mutually exclusive categories

Mutually exclusive impairment categories	NOT mutually exclusive impairment categories
Lower extremity impairment	Lower extremity paralysis
Upper extremity impairment	Cerebral palsy
Mental impairment	Paraplegia

A person who has the impairment of not being able to move their legs can only be classified in one category in the mutually exclusive list: Lower extremity impairment. The same situation has the *possibility* of being classified in three categories from the list that is not mutually exclusive: Lower extremity paralysis, cerebral palsy, and paraplegia. Mutually exclusive categories increase the validity and reliability of a measurement tool by offering one classification option for multiple users over time.

Comprehensive

Comprehensive means that the list of categories encompasses the vast majority of impairments that may inhibit the usability of medical instrumentation. Comprehensiveness increases the reliability and validity of the measurement tool by offering an impairment category to multiple users across time.

Existing Impairment-Related Categorization: Example Schemes

The reviewed examples of impairment-related categorization schemes were developed for a variety of purposes. **The schemes are analyzed against the mold of an RERC-AMI MED-AUDIT purpose of measuring the usability of medical instrumentation for people with disabilities and the foregoing measurement parameters.**

Broad Categories, Small Number of Categories: Tend to be Mutually Exclusive

A. Baldwin, M. & Johnson, W. (2000)¹:

1. Mobility
2. Strength
3. Sensory

Strength: The categories are definitive and mutually exclusive.

Weaknesses: The categories are broad, such as ‘mobility,’ and the categories are not comprehensive (i.e., skin impairment does not have a category).

B. Center for Rehabilitation Technology (2001):

1. Vision
2. Hearing
3. Mobility
4. Cognitive

Strength: The categories are definitive and mutually exclusive.

Weaknesses: The categories are broad, such as ‘mobility;’ and categories are not comprehensive (i.e., skin impairment does not have a category).

C U.S. Census Bureau (2004) and International Center for Disability Information (2004):

1. Sensory
2. Physical
3. Mental
4. Self-Care
5. Going outside the home
6. Employment disability

Strength: The categories are comprehensive.

Weaknesses: The categories are not mutually exclusive, are broad, and the conceptual definition of the categories is not consistent (i.e., ‘Physical’ is a physical impairment and ‘Self-Care’ is an activity of daily living).

D. Vanderheiden, G. & Vanderheiden, K. (1991)²:

1. Visual impairments
2. Hearing impairments
3. Physical impairments

¹ Functional limitations (factors) as defined by Baldwin, M. & Johnson, W. (2000).

² Items in brackets are discussed as special cases and situations. The paper further discusses the functional limitations of the impairment categories.

4. Cognitive/language impairments
5. [Seizure disorders]
6. [Multiple impairments]

Strengths: The categories are comprehensive. The categories are mutually exclusive if ‘seizure disorders’ and ‘multiple impairments’ are not considered categories.

Weaknesses: The categories are broad. The categories are not mutually exclusive if ‘seizure disorders’ and ‘multiple impairments’ are considered categories.

E. World Health Organization (2002):

1. Mental functions
2. Sensory functions and pain
3. Voice and speech functions
4. Functions of the cardiovascular, haematological, immunological and respiratory systems
5. Functions of the digestive, metabolic, endocrine systems
6. Genitourinary and reproductive functions
7. Neuromuscular and movement-related functions
8. Functions of the skin and related structures

Strength: The categories are mutually exclusive.

Weaknesses: ‘Neuromuscular and movement-related functions’ is a broad category.

‘Genitourinary and reproductive functions’ is not a pertinent category for categorizing a person’s ability to use medical instrumentation.

Narrowing Categories, Increased Number of Categories: With Specificity Comes a Tendency to Reduce Mutual Exclusivity and Comprehensiveness; Tendency to Increase Inconsistent Definitions

F. National Center for Education Statistics (1998):

1. Hearing impairment
2. Blind or visual impairment
3. Speech or language impairment
4. Mobility/Orthopedic impairment
5. Specific learning disability
6. Health impairment/problem
7. Mental illness/emotional disturbance
8. Other

Strengths: Categories are comprehensive due to ‘other’

Weaknesses: Categories are not specific enough for items such as skin impairment; categories are not mutually exclusive (i.e., ‘health impairment/problem’ could encompass many of the other categories); categories are not comprehensive (i.e., ‘cognitive’ is not specified); some categories are broad, such as ‘mobility;’ and ‘specific learning disability’ is not defined adequately.

Overall, the conceptual definition of the categories is not consistent (i.e., ‘hearing impairment’ is an impairment and ‘specific learning disability’ is a disability).

G. Statistics New Zealand (2001):

1. Hearing
2. Seeing

3. Mobility
4. Agility
5. Speaking
6. Intellectual
7. Psychiatric/Psychological
8. Other

Strength: Categories are comprehensive due to 'other.'

Weaknesses: Categories are not mutually exclusive (i.e., 'mobility' and 'agility' are often the same impairment; and categories are broad, (e.g., 'mobility' and 'other').

H. Santa Clara Medical Center (1999):

Arousability, Awareness, & Responsivity

1. Eye opening
2. Communication ability
3. Motor response

Cognitive Ability for Self Care Activities

4. Feeding
5. Toileting
6. Grooming

Dependence on Others

7. Level of functioning

Psychosocial Adaptability

8. Employability

Weaknesses: Categories are not mutually exclusive; categorizes impairments and activities of daily living which have different conceptual definitions; and categories are not comprehensive (i.e., skin impairment does not have a category).

I. Kurtzke Expanded Disability Status Scale [EDSS] (2002):

1. Pyramidal
2. Cerebellar
3. Brainstem
4. Sensory
5. Bowel and bladder
6. Visual
7. Cerebral
8. Other

(The above functional systems are further classified according to level of disability, normal to death)

Strength: Categories are comprehensive due to 'other.'

Weaknesses: Categories are broad; and categories have inconsistent conceptual definitions (i.e., 'brainstem' is anatomical feature and 'sensory' is a function or limitation).

J. Jahnsen, R., Villien, L., Egeland, T., Stanghelle, J., & Holm, I. (2004):

Type of condition:

1. Hemiplegia
2. Diplegia

3. Quadriplegia
4. Dyskinesia
5. Unknown

Cross-tabulated by characteristics:

6. Walking without support (various distances)
7. No support inside – support outside
8. Walking with support – total (various distances)
9. Not walking – total (when stopped/never started)
10. Use of wheelchair (degree of use)

Weaknesses: Categories are not mutually exclusive; categories have different conceptual definitions (cross-tabulation uses two different conceptual types of variables); and categories are not comprehensive (i.e., skin impairment does not have a category).

K. E & D Functional Classification (1998):

1. Skeletal – Motion of lower limbs
 2. Skeletal – Motion of upper limbs
 3. Skeletal – Motion of upper body
 4. Skeletal – Anthropometrics
 5. Skeletal – Coordination and dexterity
 6. Skeletal – Force
 7. Visceral
 8. Vision
 9. Hearing
 10. Language and speech – Communication
 11. Intellectual/Psychological – Cognitive
- Strength: Categories are mutually exclusive.

Weaknesses: Categories are not comprehensive (i.e., skin impairment does not have a category); and categories have different conceptual definitions (i.e., ‘Anthropometrics’ is the study of body measurement and ‘motion of upper body’ is a physical ability).

L. Allen, S., Rainwater, A., Newbold, A., Deacon, N., & Slatter, K. (2004) [2 groups of variables selected from many employment-related variables]:

From one group:

1. Current symptoms
2. Aggravating/relieving factors
3. Pain level
4. Location of pain

From a different group:

5. Job analysis/Demands
6. Range of motion
7. Lifting capacity
8. Static tolerances
9. Grip strength
10. Fine motor skills
11. 20 job demands (listed by U.S. Dept. of Labor)

Strength: Categories are specific.

Weaknesses: Categories have a strong focus on employment-related functions; categories are not comprehensive; not mutually exclusive (i.e., pain is often an aggravating factor for other categories); and categories have inconsistent conceptual definitions (i.e., ‘pain level’ is a symptom and ‘fine motor skills’ is a function or ability).

M. Mirowsky, J. (1995):

1. Seeing
2. Hearing
3. Walking
4. Lifting
5. Climbing
6. Grasping
7. Manipulating
8. Perceptual speed
9. Motor speed
10. Mental processing speed
11. Metabolism
12. Lung capacity
13. Bone density

Weaknesses: Categories are not comprehensive (i.e., skin impairment does not have a category); and categories have inconsistent conceptual meanings (i.e., ‘walking’ is a physical function and ‘bone density’ is an anatomical characteristic).

N. Social Security Administration (2004):

1. Musculoskeletal system
2. Cardiovascular system
3. Hemic and lymphatic system
4. Multiple body systems
5. Neoplastic diseases – malignant
6. Special senses and speech
7. Digestive system
8. Skin disorders
9. Neurological
10. Immune system
11. Respiratory system
12. Genito-Urinary system
13. Endocrine system
14. Mental disorders

Weaknesses: Categories include impairments, body systems, and disorders which are different conceptual definitions; and, categories are not mutually exclusive (i.e., ‘Multiple body systems’ encompasses the other categories).

O. Baldwin, M. & Johnson, W. (2000)³:

1. Difficulty seeing
2. Cannot see

³ Functional limitations (binary)

3. Difficulty hearing
4. Cannot hear
5. Difficulty speaking
6. Difficulty lifting
7. Cannot lift
8. Difficulty climbing
9. Cannot climb
10. Difficulty walking
11. Cannot walk
12. Difficulty with phone
13. Difficulty getting around
14. Difficulty getting in/out [of] bed
15. Cannot get in/out of bed
16. Difficulty bathing
17. Difficulty with personal care
18. Cannot personal care
19. Difficulty with money
20. Difficulty with meals
21. Difficulty with housework

Weaknesses: Categories are functional limitations and activities of daily living, not impairments, therefore, they are not mutually exclusive (i.e., ‘difficulty getting around’ and ‘difficulty walking’ are often the same impairment); and categories are not comprehensive (i.e., skin impairment does not have a category)

P. Bureau of the Census, 1992 (Baldwin, M. & Johnson, W., 2000):

Impairments that are less visible or subject to less prejudice

1. Back or spine problems
2. Broken bone/fracture
3. Head or spinal cord injury
4. Hernia or rupture
5. High blood pressure
6. Kidney stones or chronic kidney trouble
7. Stiffness or deformity of the foot, leg, arm, or hand
8. Thyroid trouble or goiter
9. Tumor, cyst, or growth
10. Learning disability
11. Stomach trouble
12. Lung or respiratory trouble
13. Diabetes
14. Heart trouble
15. Arthritis or rheumatism

Impairments that are visible and subject to more prejudice

16. Missing legs, feet, arms, hands, or fingers
17. Cancer
18. Speech disorder
19. Blindness or vision problems

20. Deafness or serious trouble hearing
21. Stroke
22. Epilepsy
23. Paralysis of any kind
24. Cerebral palsy
25. Alcohol or drug problem
26. Mental or emotional problem
27. Mental retardation
28. AIDS

Weaknesses: Categorizes physical impairments, illnesses, and disorders which have different conceptual definitions and are therefore not mutually exclusive (i.e., ‘stiffness’ is a symptom of ‘Arthritis’).

Discussion

The need for the RERC-AMI MED-AUDIT impairment category measurement parameters (consistent conceptual definition, mutually exclusive, comprehensive) is demonstrated in the review of the preceding examples of impairment-related categorization schemes. In addition, the number of categories is of importance as the number of categories must be high enough to be comprehensive and as specific as possible, while being low enough to make mapping the physical limitations to tasks and medical instrumentation feasible.

The variety of contexts in which the examples of existing impairment-related categorization schemes were formed restricts clear and consistent conceptual definitions of impairment categories. The impairment schemes do not appear to be empirically-derived measurement tools. They were expert-derived and developed as resource instruments, lists directed to specific areas of research (e.g., employment), and special interests, among others.

The RERC-AMI MED-AUDIT process of developing an impairment categorization scheme is statistically and methodologically valid and reliable. Beginning with the measurement parameters discussed in the foregoing, supported by the reviewed literature, RERC-AMI plans to develop the impairment categorization scheme utilizing both an empirical and expert approach.

The RERC-AMI MED-AUDIT impairment categorization scheme will be subjected to a diagnostic challenge, consisting of categorizing impairments found by experts to be common to various conditions and disabilities. This step will validate the comprehensiveness of the scheme. Inter-rater reliability will be tested by groups of users to establish the reliability of the MED-AUDIT impairment scheme.

Results

Development of a RERC-AMI MED-AUDIT impairment scheme is a continuing process. Based on the reviewed literature, expert input, and the MED-AUDIT working group, the following is a preliminary list of impairment categories.

1. Auditory sensory impairment
 1. a. Hard of hearing
 1. b. Deaf
2. Vision sensory impairment
 2. a. Low vision
 2. b. Blind
3. Speech impairment: Motor
4. Intellectual (cognitive)
 4. a. Language
 - *4. a. 1) Expression
 - *4. a. 2) Comprehension
 - *4. b. Comprehension: Social/environmental
 - *4. c. Reasoning
 4. d. Memory
 - *4. d. 1) Short-term
 - *4. d. 2) Long-term
5. Skin and connective tissue impairment
 - *5. a. Integrity
 5. b. Hypersensitivity
 5. c. Lack of sensitivity
6. Other sensory impairment (olfactory, gustatory, chemical, etc.)
7. Mental and behavioral impairment (e.g., mental illness)
8. Lower limb impairment
 8. a. Paralysis
 8. b. Tremor/spasticity
 - *8. c. Contracture
 8. d. Pain
 8. e. Weakness
 8. e. 1) Muscle
 8. e. 2) Bone
 - *8. f. Proprioception
 8. g. Missing limb or missing part of limb
 - *8. h. Coordination
 - *8. i. Balance
9. Upper limb impairment
 9. a. Paralysis
 9. b. Tremor/spasticity
 - *9. c. Contracture
 9. d. Pain
 9. e. Weakness
 9. e. 1) Muscle
 9. e. 2) Bone
 - *9. f. Proprioception
 9. g. Missing limb or missing part of limb
 - *9. h. Coordination
 - *9. i. Balance

- 10. Head, neck, and trunk
 - 10. a. Paralysis
 - 10. b. Tremor/spasticity
 - *10. c. Contracture
 - 10. d. Pain
 - 10. e. Weakness
 - 10. e. 1) Muscle
 - 10. e. 2) Bone
 - *10. f. Proprioception
 - *10. g. Balance
- 11. Overall body
 - *11. a. Endurance/fatigue
 - 11. b. Weakness
 - 11. b. 1) Muscle
 - 11. b. 2) Bone
 - 11. c. Respiratory
 - *11. d. Balance
 - *11. e. Spatial Perception

Categories that are preceded by an asterisk “*” were added by the RERC-AMI MED-AUDIT team and are considered important impairment categories when considering the usability of medical instrumentation. The remaining categories are adapted from the reviewed literature and tailored to the MED-AUDIT purpose. This categorization scheme attempts to meet the measurement parameters discussed previously (consistent definition, mutually exclusive, and comprehensive).

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