COMMENTARY

Toward a Taxonomy of Rehabilitation Interventions: Using an Inductive Approach to Examine the "Black Box" of Rehabilitation

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A barrier in outcomes and effectiveness research is the ability to characterize the interventions under review. This has been the case especially in rehabilitation in which interventions are commonly multidisciplinary, customized to the patient, and lack standardization in definition and measurement. This commentary describes how investigators and clinicians, working together, in a major multisite stroke rehabilitation outcome study were able to define and characterize diverse stroke rehabilitation interventions in a comprehensive, yet parsimonious, fashion and thus capture what actually transpires in a hospital-based stroke rehabilitation program. We consider the implications of the study's classification system for a more comprehensive taxonomy of rehabilitation interventions and the potential utility of such a taxonomy in operationalizing practice standards, medical record keeping, and rehabilitation research.

Key Words: Classification; Rehabilitation; Taxonomy.

AN ENDURING QUESTION in rehabilitation—and health care in general—is whether and to what extent interventions used are effective, and, if so, whether they are efficient. In answering these questions, one must know the ends that are being sought—outcomes that are of value to patients, payers, and society as a whole. Over the years, rehabilitation has expended enormous intellectual energy conceptualizing models of disability, identifying relevant outcome domains, and developing outcome measures, including psychometric (clinimetric) research on validity, reliability, scaling, and interpretation of these measures.

By contrast, little energy has been expended on issues related to the processes of care and interventions used in rehabilitation. The *input side* (patient, treatment, and environment characteristics) has not been subjected to the same level of conceptual and methodologic rigor as the *output side* in the effectiveness equation, and there has been little systematic disaggregation (conceptualizing, measuring, counting) of interventions used in rehabilitation. Although there is research of individual treatments, focusing on their effectiveness either as "stand alone" interventions in an outpatient setting or as part of a larger package of inpatient or outpatient services, there is no research that investigates the contribution of all individual components of a rehabilitation program to the outcomes, individually and combined.

Typically, outcomes research or effectiveness research has examined "unopened" packages of services, gross settings of care, or organizational milieus (eg, rehabilitation team culture). Most previous studies[1,2] have examined rehabilitation in the aggregate; investigators have looked at rehabilitation as a whole, such as comparing outcomes of patients treated in hospital rehabilitation centers versus those treated in skilled nursing facilities. Quantifying the amount of therapy that a patient receives usually does not go beyond length of stay or hours of each type of therapy delivered.[3-5] Rarely are individual interventions examined in the context of the entire array of interdisciplinary interventions used and within the structural arrangements (ie, care settings) in which care is delivered. In the case of stroke rehabilitation, for example, no study has investigated the effects of multiple aspects of stroke rehabilitation simultaneously, although some explorations of the effects of structural and process characteristics of the treatment environment have been published.[6-9] In short, we have yet to disassemble the "black box" of rehabilitation.

As a result of our failure to disaggregate, we cannot identify those interventions that truly contribute to rehabilitation outcomes. Even if we could distinguish the "active ingredients" in rehabilitation, we would still need to quantify them, which depends on adequate measurement. Each intervention presents its own measurement challenge and rehabilitation interventions often are not mutually exclusive. For example, a physical therapist may combine motor learning strategies with balance training while working with a patient on sit-to-stand activities. Both are important related components of therapy and sometimes difficult to differentiate. Separating the effects of individual interventions and their multiple interactions is an analytical and statistical challenge. Rehabilitation practitioners

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claim that rehabilitation is an interdisciplinary process that is more than the sum of its parts. That may be the case, but without identifying and measuring the parts, we cannot begin to evaluate the whole. Some parts may not be necessary or can be substituted for each another. Optimal interventions may be different for various diagnoses, admission functional levels, or comorbidities.

Some[10] have called for a taxonomy of treatments that will bring systemization, greater clarity, and more precision to describing and quantifying what happens in the rehabilitation process, and thus serve as the basis for measuring interventions used in conjunction with outcomes. The notion of a taxonomy suggests creation of a system of concept categories, classes, or groups into which individual observations can be lumped. For our purposes, a taxonomy is not a grand classification scheme, such as Linnaeus's historic organization of the plant and animal kingdoms of the world, but a typology that brings order and rigor to the description of myriad rehabilitation interventions. The purpose of a rehabilitation interventions taxonomy is to characterize systematically the many treatments, procedures, and interventions used in rehabilitation, taking into account their multidimensionality with respect to content (type), purpose, intensity, duration, sequence, frequency, and other characteristics of care rendered.

The purpose of the present article is to sketch an approach to the development of a taxonomy of rehabilitation interventions. The approach is the byproduct of a major outcomes study in stroke rehabilitation. Although we did not intend to develop a grand and comprehensive rehabilitation taxonomy, the approach used in the study can inform the development of such a scheme. Thus, our purpose was not to propose a definitive taxonomy but to share our experiences that can help inform more definitive attempts in the future. Our article (1) outlines experiences in developing taxonomies in other health care fields, such as nursing, (2) considers 2 main approaches to developing a rehabilitation intervention taxonomy, (3) describes the larger study on stroke rehabilitation outcomes that led to our approach, (4) presents an example of the classification scheme used in that study, (5) introduces proposed criteria for an intervention classification system and discusses the limitations of the current study relative to these criteria, (6) discusses the implications for the development of clinical practice guidelines (CPGs) and electronic medical records, and (7) identifies some of the implications for rehabilitation research.

TAXONOMY DEVELOPMENT IN OTHER HEALTH CARE FIELDS

Taxonomies have been part of health care for many years. The *International Classification of Diseases, 9th Revision*[11] is a taxonomy of diseases and health conditions. The *International Classification of Impairments, Disabilities and Handicaps*,[12] now the *International Classification of Function*, is a taxonomy to address the multiple dimensions of disability. Current Procedural Terminology codes are a billing taxonomy used in health care.[13] A number of taxonomies have been developed for nursing, of which the Nursing Intervention Classification (NIC) is the most extensive and best known.

The NIC addresses the range of activities that nurses carry out in daily routines.[14] The NIC developers started with extensive listings of specific nursing activities as found in nursing textbooks, care planning guides, and information systems. These were grouped into interventions using expert opinion, focus groups, and other methods. "Purification" was achieved by using Delphi processes with experts who rated domains and classes on clarity, homogeneity, inclusiveness, mutual exclusiveness, and theory neutrality.

In its current edition, the NIC consists of 486 interventions. Each is comprised of a label, a definition, and a set of activities (as many as 20) that together characterize the intervention. Each intervention is in turn classified within 1 of 30 classes within 7 domains: physiologic, basic; physiologic, complex; behavioral; safety; family; health system; and community. Examples of nursing interventions are the following: *epidural analgesia administration* is defined as "preparation and delivery of narcotic analgesics into the epidural space," *cough enhancement* refers to a group of nursing activities intended to help respiration, and *airway management* includes activities such as endotracheal and nasotracheal suctioning. Some nursing interventions in the NIC include activities that overlap with other interventions. Many, if not most, interventions and their component activities cut across medical diagnostic categories.[14,15]

The NIC authors specify that the list of interventions can be used to make visible and legitimate the work that nurses do. However, other uses are described also: standardizing and defining the knowledge base for nursing education and practice, facilitating communication among nurses and of nurses with other care providers, teaching clinical decision making, staff needs planning by administrators, and investigating the effectiveness and cost of nursing care.[14] The NIC's editors assert that "NIC, although still relatively young, promises to be a major rallying point for nurses in the decades to come."[15] A little over a decade in the making, the NIC's research applications appear secondary to its clinical, educational, and administrative uses. To date, we do not have a large body of research studies that use the NIC as the principal means of characterizing the nursing interventions under review, and even fewer studies that use the NIC to describe interventions that are compared on their impact on patient outcomes.

APPROACHES TO REHABILITATION TAXONOMY DEVELOPMENT

Deductive Approach

There are 2 main approaches one can take to develop a taxonomy of rehabilitation interventions. The first is a theory-driven, top-down, deductive approach led by expert opinion and scientific evidence (where such evidence is available). The approach stems from a profession's or practice area's view of its self-identity and its professional belief system. Good theory is believed to be the precursor to good science and is important to the legitimacy of a profession or area of practice. The natural inclination is to assemble a group of experts and to define deductively a rational ordering of interventions within their scope of practice with little attention to whether the distinctions made correspond to differentiations visible in the practice of rehabilitation.

Inductive Approach

The second approach is an experience-driven, bottom-up, inductive approach led by front-line opinion and scientific evidence (where such evidence is available). This approach starts with what people do in the clinical setting, taking into account the multidimensionality of each intervention and multidisciplinary interaction. It gathers front-line clinicians to describe and characterize what they actually do and then categorizes meaningfully the various interventions using a common language. An even more empirical method is to cull from existing materials (eg, medical records, textbooks, articles in the literature) descriptive terms and statements referring to activities, to sort them, and then to summarize them as a first step toward development of conceptual classes—the approach taken by the developers of the NIC.[13,14]

These 2 approaches are not mutually exclusive. A limitation of the deductive method is that theory may overlook important behaviors and distinctions that may not fit the theory. Presently, rehabilitation lacks theory, particularly a comprehensive theory that encompasses the links between impairments, treatments, and outcomes for all patient problems in all diagnostic groups. A limitation of the inductive approach is that one may not see how disparate interventions fit together. Thus, the second approach needs to incorporate theory at some level.

A taxonomy developed using either approach needs to show its value. Later we describe the development of a limited taxonomy that uses the second approach to characterize interventions in stroke rehabilitation. The taxonomy was developed as part of a stroke outcomes study by using the clinical practice improvement (CPI) study method. This taxonomy is being implemented at clinical sites around the United States and abroad. We describe the process and discuss potential implications for a broader, more cohesive medical rehabilitation taxonomy.

THE STROKE REHABILITATION OUTCOME STUDY

Purpose, Scope, and Approach

The stroke rehabilitation outcomes study addressed the need for scientific data that support the effectiveness of rehabilitation treatments. The study included 7 clinical sites, 6 in the United States and 1 in New Zealand. Each site contributed 200 stroke survivors for a total of 1400 study participants.

The study used what has come to be called the CPI study method because it allows one to identify and analyze specific components of the stroke rehabilitation process to determine how each component contributes to outcomes.[16] The CPI analyzes the content and timing of individual steps of the health care process, with the goal of improving clinical outcomes at the lowest necessary cost. It involves the development of a comprehensive database linking patient characteristics, treatment factors, environmental factors, and outcomes to examine simultaneously all factors that influence the care process.[16]

Because the effects of stroke can be wide ranging, it is a challenge to make the right match between a stroke survivor's needs and rehabilitation services. Failure to find the right fit can result in the wrong type of therapy or too little or too much of the right type of care for a patient. But we cannot allocate appropriate rehabilitation services to stroke patients responsibly (clinically and fiscally) if there is little scientific evidence showing the effectiveness of specific poststroke rehabilitation interventions for specific deficits. The main goal of the CPI stroke project is to identify empirically the patient factors and specific interventions in poststroke rehabilitation that are associated with better outcomes. Only those aspects of the project that are directly relevant to taxonomy development are described here.

Patient Characteristics, Processes of Care, and Outcomes

In a CPI study, practicing front-line professionals define the patient characteristics, the treatment processes, environmental variables, and outcomes (eg, change in FIM™ instrument score) to be studied.[16]

Patient characteristics. The study team selected a large array of relevant patient characteristics that also took into account the patient's prestroke history, social support, and cognitive functioning. The Comprehensive Severity Index (CSI) was our primary severity adjustment method.[16-25] The CSI provides an objective, consistent method to quantify patient severity of illness levels based on signs, symptoms, and physical findings of a patient's disease(s).[17-25]

Processes of care. Details about therapist treatments, their intensity, duration, and so forth, were collected along with information about other treatment steps including use of intermittent pneumatic compression, time to first mobilization, time to first rehabilitation, pain management, presence and amount of psychiatric intervention, functional electric stimulation, bowel and bladder training programs, Foley catheter use, change position schedule, seating devices–pressure relief, review of imaging results, use of durable medical equipment, medications, nutritional support, and patient and family education topics.

Development of Standardized Documentation Forms

The initial intent of the stroke rehabilitation outcome study was to use information contained in existing rehabilitation patient chart documentation to examine process variables for poststroke patients. However, clinical representatives from the participating sites pointed out that detailed information about therapist treatments, their intensity, and duration are not typically available in current charts. They recommended strongly that if we were to succeed in determining best care (ie, most effective for a specific set of deficits), we must first have each member of the rehabilitation team describe precisely what he/she does. The participating sites recommended extensive clinical intervention documentation in a standardized format, something that had not been done before in rehabilitation care. The goal of this standard documentation format was to provide clinicians with a tool that would assist them in recording what treatments and interactions with the patient and/or family and/or other members of the care team occur during a treatment session, shift, or day. In developing and finalizing the documentation forms, great care was taken not to duplicate documentation that clinicians routinely record in other parts of the chart. The purpose of the new documentation forms was to document actual practice—not necessarily what will generate reimbursement or satisfy outside review boards.

Multidisciplinary teams of clinical specialists from participating study sites met weekly via telephone conference calls from the beginning of the study (March 2000) to discuss study issues, including how to conceptualize and design a specific intervention documentation form for each rehabilitation discipline. In addition, subcommittees of physicians, nurses, psychologists, social workers, and physical, occupational, recreational, and speech-language pathology therapists conducted conference calls for a period of 8 months to develop a documentation form to capture details about intervention nature, intensity, duration, sequence of care, and frequency of care necessary to create an accurate picture of the contribution made by that discipline to rehabilitation care.

As these subcommittees discussed interventions to include, it became apparent that clinicians in different parts of the United States practice differently. For example, some physical therapists use constrained-induced movement therapy; others never use this therapy. Following the CPI methodology, we included all interventions that were possible in any of the participating sites. This approach preempted disagreement among therapists during the development process as to what practices are best and allowed all therapists using the forms to document all therapies they performed.

As the subcommittees of clinical specialists from different centers worked together in developing the documentation forms, it also became apparent that practitioners in the same discipline from different institutions or parts of the United States use various terms to describe similar treatments. This required the subcommittees to develop common definitions of terms that could be used on the forms and thus ensure that the

data collected were based on a common vocabulary. Further, each clinical subcommittee decided on the frequency with which their form would be completed to have an adequate picture of changes in the type or intensity of therapies rendered over a patients' stay. Some of the forms are used for every patient encounter (physical therapy [PT], occupational therapy [OT], recreational therapy, speech-language pathology therapy), others for every shift (nursing), and others are multiday forms (medicine, social work)

When the subcommittees completed the "final first" draft of their form, each site representative used the form with actual patients. Form utility and content were then tested on a limited basis; comments were brought back to the subcommittee and used to continue form revision. This preliminary testing went on for about a month before the forms underwent a 1-month pilot test in which clinicians used the forms on many unidentified patients. Again, comments contributed to form revisions.

Each subcommittee developed the content of their documentation form as they deemed appropriate, not based on burden of completion; however, completion burden was a big concern. The pilot test at the end of the development process found that documentation forms for each therapy session took between 30 seconds and 3 minutes to complete. Clinical staff members did not find them overly burdensome. After approximately 9 months of use, clinicians in each rehabilitation specialty estimated the average number of minutes to complete the standardized documentation for 1 therapy session was less than 2 minutes with a median of less than 1 minute.

Each study site received a syllabus cum training manual that contained paper and electronic copies of each clinical discipline's intervention documentation form, instructions for completing each form, and definitions for all terms used on each form. Written case studies were also included to show how to complete each form based on a patient scenario. Additional case studies were used to evaluate the trainees' understanding of the instructions. Representatives from each sites' clinical disciplines participated in telephone training sessions specific to that discipline. After the telephone training session, each site's clinical leaders conducted on-site training sessions for their coworkers. Follow-up telephone conference calls for each clinical specialty group were conducted during the 2 months after training to provide an opportunity for clinicians to discuss implementation issues and ask questions of their peers in other institutions.

To show the process used by each of the 8 clinical specialty groups, we describe the development of the PT classification scheme.

The PT Classification Scheme Development and Use

The PT intervention classification scheme was developed through the combined effort of 1 or more physical therapists from each of the study's initial 5 participating rehabilitation centers in different regions of the United States. The process began with discussions of the conceptual framework for PT interventions used in poststroke rehabilitation and consideration of potential classification schemes. The subcommittee began by examining the *Guide to Physical Therapist Practice*,[26] which is a thorough description of practice developed by the American Physical Therapy Association using expert consensus. The *Guide* was not developed as an intervention classification scheme, but it does provide an extensive list of interventions used by physical therapists for various patient and client diagnostic groups, which are termed practice patterns. The practice pattern that includes the diagnosis of stroke lists 48 major intervention categories. However, after careful review, the PT subcommittee determined that the interventions listed in the *Guide* were not organized to allow for a clear and distinct classification of interventions and lacked a conceptual framework that was suitable to reflect actual practice. Therefore, we did not use the interventions listed in the *Guide*, but we used the *Guide*'s terminology and definitions whenever possible.

Subcommittee members discussed the theoretical underpinnings of the various therapeutic approaches used in stroke rehabilitation to identify appropriate organizing themes for classifying PT interventions. Our goal was to develop a stroke intervention classification scheme that captured the complexity of treatment with sufficient detail to distinguish different interventions while simultaneously maintaining parsimony. The group agreed on using functional activities as a key organizing theme or classification dimension for PT interventions because this approach emphasizes the importance of functional activities as a critical component in various therapeutic approaches. Figure 1[27-29] is a schematic diagram of the conceptual framework underlying the intervention classification system for PT. It identifies 10 functional activities that serve as the core organizing feature. These 10 functional activities are important to patient goals and functional outcome measures and include key activities with a range of difficulty from elemental (bed mobility) to advanced (community mobility).

We identified body systems as a second classification dimension. The neuromuscular, musculoskeletal, cardiopulmonary, and cognitive/perceptual/sensory body system dimensions further classify various interventions because, after a stroke, impairments in any or all of these systems can impede performance of functional activities and PT interventions are directed at minimizing these affects. Figure 1 also shows the classification of PT interventions organized by the body systems they target. The 2 main dimensions, functional activities and body systems, when combined, maximize the level of detail that can be captured. These dimensions also yield numerous combinations that capture the multidimensionality of clinical practice. They are a conceptually sound and efficient way to categorize PT interventions. A therapy session is often structured around functional activities that appropriately challenge a patient's functional ability, and, in the context of these activities, interventions are directed at ameliorating the specific impairments that limit function. Thus, the functional activity and body system dimensions of the classification system reflect critical aspects of clinical practice. As figure 1 shows, neuromuscular interventions (1–8) are always done in the context of a functional activity. Musculoskeletal interventions (9–13) and modalities (27–29) can be done in the context of a functional activity or separate from a functional activity and directed toward a specific area of the body, such as the upper extremity (60), lower extremity (61), trunk (62), or head and neck (63). Interventions for impairments in cardiopulmonary (14, 15) or cognitive/perceptual/sensory systems (16–19) can be done in the context of a functional activity or separately. Other generic interventions, such as education (20–22), pet therapy (30, 31), and assistive devices (32–58), are not specific to a body system and can be done in the context of a functional activity or separately, whereas interventions related to equipment (23–26) and patient assessments are always documented separate from functional activities.

The documentation form in use. To complete the documentation grid, a therapist records the duration of each activity in 5-minute intervals and lists codes for the interventions used. Time for formal assessments, home evaluation, and work site evaluations are recorded separately. We describe interventions and demonstrate coding of a PT treatment session for a patient with left-sided hemiparesis and hemi-inattention. The 45-

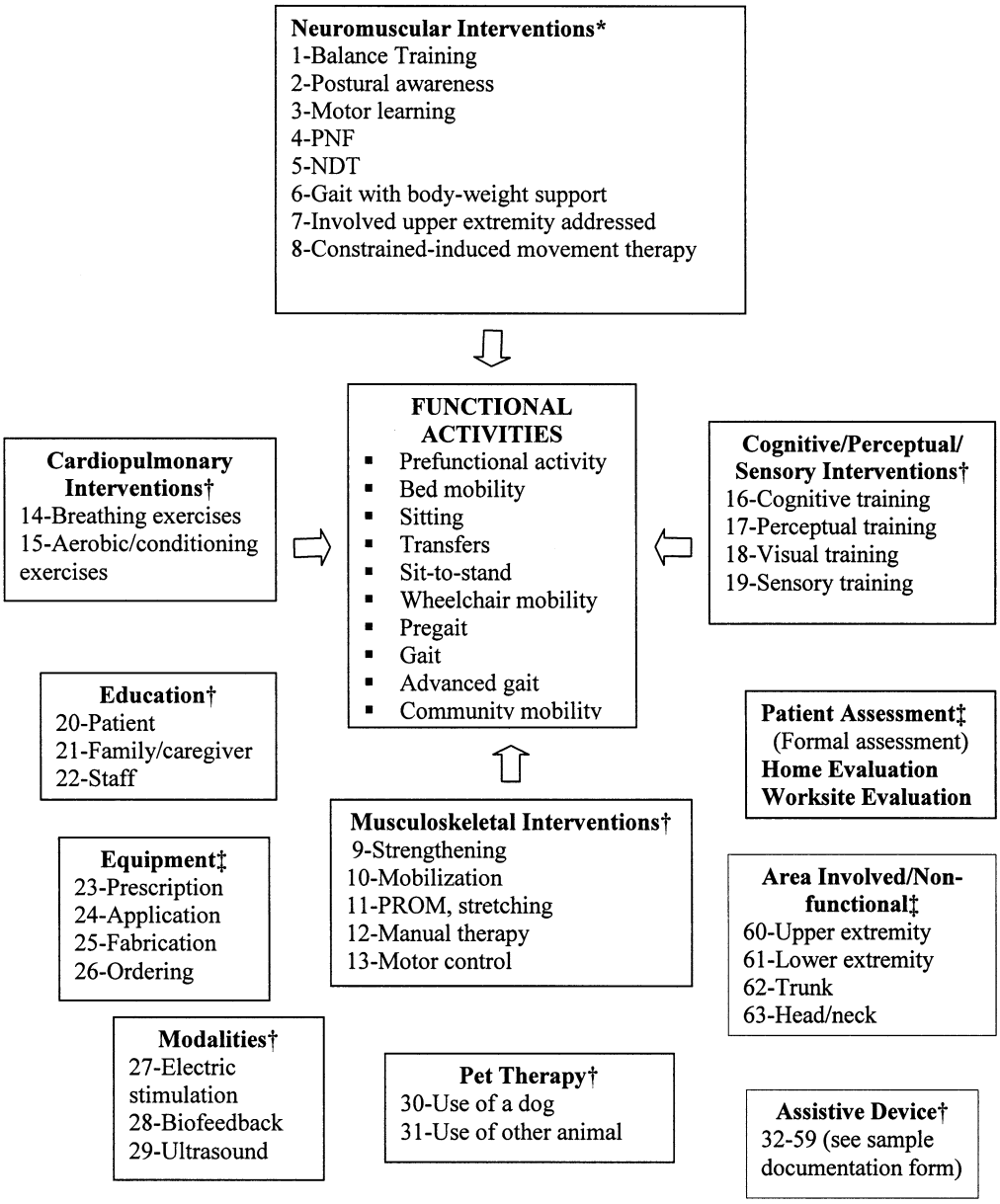

Fig 1. Framework of the intervention classification system in poststroke PT. *Always documented in the context of functional activities. †Documented in the context of functional activities or separately. ‡Always documented separate from functional activities. Abbreviations: NDT, neurodevelopmental treatment; PNF, proprioceptive, neuromuscular fasciculation reaction; PROM, passive range of motion.

minute treatment session consisted of 4 functional activities directed at impairments in 4 body systems and shows the complexity and multidimensionality that is captured by the intervention classification system. Figure 2 presents a completed documentation form that shows intervention coding. As the example illustrates, the documentation form provides an efficient method to describe the details of a complex PT intervention.

The PT session began with a transfer from the wheelchair to the mat table (duration of transfers activity, 5min). The therapist and patient discussed the steps involved in transferring safely (patient education is code 20) and awareness of the left arm and leg during the transfer was emphasized (perceptual training is code 17). After the transfer, the therapist worked on sitting balance (duration of sitting activity, 15min) by having the patient clasp the involved and noninvolved hands together and reach targets placed to the left, right, and forward (balance training is code 01; involved upper extremity addressed is code 07). Targets to the left were emphasized and the patient was instructed to visually scan the left visual field to find the targets (code 17). Initially, the therapist used manual and verbal cues to encourage proper alignment of the trunk (neurodevelopmental treatment is code 05) and then encouraged the patient to self-assess and correct alignment (motor learning is code 03). During the forward weight shift, the activity transitioned into preparation for standing (duration of sit-to-stand activity, 10min) and the therapist used manual and verbal cues to encourage the patient to maintain midline alignment of the trunk (code 17; code 05). The involved lower extremity was positioned to bear more weight on the left, and the patient completed 10 repetitions of moving from the seated position to holding in a squat position for a few seconds (strengthening is code 09). The patient was asked to remember the steps required for a safe transfer and transferred back to the wheelchair. The patient then worked on walking (duration of gait activity, 15min) with body-weight support (gait with body-weight sup-

Physical Therapy Rehabilitation Activities

6649

Patient ID: Sample19

Therapist: DOE

Date of Therapy Session: 03/15/02

Time session begins: 08:00

INTERVENTION CODES

Neuromuscular Interventions:
01. Balance training
02. Postural awareness
03. Motor learning
04. PNF
05. NDT
06. Gait with body weight support
07. Involved upper extremity addressed
08. Constrained induced movement therapy

Musculoskeletal Interventions:
09. Strengthening
10. Mobilization
11. PROM/Stretching
12. Manual Therapy
13. Motor Control

Cardiopulmonary Intervention:
14. Breathing
15. Aerobic/Conditioning exercises

Cognitive/Perceptual/Sensory Interventions:
16. Cognitive training
17. Perceptual training
18. Visual training
19. Sensory training

Education Interventions:
20. Patient
21. Family/Caregiver
22. Staff

Equipment Interventions:
23. Prescription/Selection
24. Application
25. Fabrication
26. Ordering

Modality Interventions:
27. Electrical Stimulation
28. Biofeedback
29. Ultrasound

Pet Therapy:
30. Use of dog
31. Use of other animal

Assistive Device:
32. Ankle dorsi flex assist
33. Cane - Large base
34. Cane - Small base
35. Cane - Straight
36. Crutches - Axillary
37. Crutches - Forearm
38. Crutches - Small base forearm
39. Dowel
40. Grocery cart
41. Hemirail
42. Ironing board
43. KAFO
44. Lite gait
45. Mirror
46. Parallel bars

	Duration of Activity: Enter in 5 minute increments.	Interventions: Enter one intervention code per group of boxes.
Pre-Functional Activity		
Bed Mobility		
Sitting	15	17 05 03 01 07
Transfers	05	20 17
Sit-to-Stand	10	17 05 09
Wheelchair Mobility		
Pre-gait		
Gait	15	06 32 44 03 15
Advanced Gait		
Community Mobility		
Intervention not related to functional activity		
Intervention #2 not related to functional activity		

47. Platform (parallel bars or FWW)
48. Standing frame
49. Steps (various heights)
50. Step ladder
51. Swedish knee cage
52. Swiss ball
53. Tray table
54. Walker - FWW
55. Walker - Hemiwalker
56. Walker - Rising Star
57. Walker - Standard
58. Wheelchair

Other:
59.

Area Involved/non-functional:
60. Upper Extremity
61. Lower Extremity
62. Trunk
63. Head/Neck

Co-Treat:
No. of minutes: Disciplines:

Patient Assessment:
Formal Assessment (initial, re-evaluation, discharge): minutes
Home Evaluation: minutes
Work Site Evaluation: minutes

Physical Therapy Time:

Physical Therapist	PT Assistant	PT Aide/Tech	PT Student
045 minutes	minutes	minutes	minutes

Group Physical Therapy Time:
PT Group/Dovetail: minutes
Enter the number of each that participated in the Group PT:

Patients	Therapists	Assistants	Aides/Techs	Students

Fig 2. Example of a completed documentation form. Abbreviations: KAFO, knee-ankle-foot orthosis; FWW, forward-wheel walker.

port is code 06; assistive devices, ankle dorsiflexion assist is code 32; lite gait is code 44). While walking, the patient used a target on the floor to guide placement of the left foot during stepping (code 03) and was instructed to work to fatigue before resting (aerobic/conditioning exercises is code 15).

Integration Across Disciplines

The study team sought a high level of conceptual integration across the disciplines. The 2 main conceptual dimensions used in PT, functional activity and body system, also served as the 2 main axes for the other 2 main rehabilitation therapies, OT and speech therapy. Every effort was made to use, wherever possible, a common language and nomenclature allowing for differences to occur in describing activities that are specific to each of the 3 therapies.

Documentation forms for other disciplines were designed somewhat differently and sought to capture intervention information that might not relate to the 2 dimensions noted earlier. For example, physicians, nurses, and social workers are heavily involved in care coordination activities,—for example, dealing with payers, discharge planning, and community reentry—and thus, care coordination became a principal component across these disciplines.

One drawback in some of the study's documentation forms was that—in an effort to minimize clinical staff burden—they were intended to supplement information already collected. The next step would be to integrate intervention classification schemes with typical assessments and intervention documentation into a comprehensive documentation format that would replace fragmented documentation processes that currently exist. The study's database, however, lets investigators integrate data from all known sources in a conceptually consistent manner.

CRITERIA FOR AN INTERVENTION CLASSIFICATION SYSTEM

Various observers[10,30,31] have proposed criteria for a sound intervention classification system. Building on their suggestions, we propose several potential criteria that can help put the findings of the present study into a broader perspective and help lay the foundation for a future rehabilitation classification system.

1. Theoretical integrity. The classification, whether developed deductively or inductively, makes theoretical and conceptual sense.
2. Domain completeness. The system addresses all the key domains of clinical intervention under review.
3. Multiple dimensions. The system captures the multidimensionality of the interventions where such multidimensionality exists.
4. Granularity. The system provides a sufficient level of detail to adequately describe and characterize the group of interventions under review.
5. Parsimony and nonredundancy. The system describes the interventions, including complex interventions, in an efficient, nonburdensome, and nonredundant way.
6. Clinical and research utility. The system is viewed as useful in the everyday practice of clinicians, researchers, and third-party users.
7. Reliability. The system is used and interpreted similarly across different treatment settings, different users, different diagnoses, and across time.
8. Future development. The system allows for growth and development as new interventions are developed and introduced into clinical practice.

Few, if any, classification systems can meet all the criteria simultaneously. Although the criteria are not necessarily mutually exclusive, future rehabilitation classification systems will entail some degree of trade-off. For example, the domains completeness (criterion 2) and granularity (criterion 4) are likely to compete with parsimony (criterion 5). The selection of criteria should be dictated by the primary purpose or application of the taxonomy under development: scientific description of practice, routine documentation, and billing for services.

Study Limitations

We cannot state with certainty that our approach to rehabilitation intervention description and classification meets all of these proposed criteria. Most of them are inherently subjective. We lack external benchmarks by which to determine whether the proposed criteria have been partially or fully attained. We can, at this time, report the subjective views of our study investigators and clinicians who used the study's classification and documentation system. They report, for example, that the complexity of rehabilitation (ie, criteria 2, 3, 4) was easier to capture than was first thought. In other words, despite the complexity, we were able to characterize interventions in a fairly parsimonious way (criterion 5). Participating clinicians believe that the classification and documentation system developed for stroke rehabilitation study can greatly improve traditional clinical documentation systems when these process recordings are added to traditional recordings of patient functional status and disease progression. We do not know whether this classification and documentation system can be generalized to other diagnostic groups served by rehabilitation or to different settings (eg, subacute or outpatient care). Nor is there evidence at this time that all significant interventions used in stroke rehabilitation are captured, or captured with sufficient detail, by the taxonomy as developed to date.

Empirical research is also needed to provide evidence of reliability (eg, interobserver reliability, recall bias), completeness of data, and the intervention data's relevance to patient outcomes. Many of these issues must be addressed before the study's approach can be recommended for widespread clinical use. Nonetheless, the study investigators obtained a high level of clinical input and consensus, sought a high level of conceptual and linguistic integration, conducted extensive pilot testing, prepared supplementary materials (eg, user guides), and provided extensive training—all of which bode well for both validity and interrater reliability.

IMPLICATIONS FOR FUTURE DEVELOPMENT

Clinical Practice Guidelines

The degree to which the participating clinicians have embraced the study's classification and documentation systems as addressing what they do in everyday practice bodes well for the development of future rehabilitation classification systems. And a sound rehabilitation classification system may, for example, help overcome the lack of specificity that often characterizes CPGs and best practice standards, thus reducing their utility in actual practice.[32] In the future, rehabilitation classification systems may aid in the development of decidable and executable CPGs and best-practice standards, that is, CPGs and standards with specific process steps to follow based on deviations of a patient's signs and symptoms from normal values and deficits.

Electronic Medical Records

Further, parsimonious classification and documentation systems may aid the development of electronic medical records in

rehabilitation. Rehabilitation's inter- and multidimensional approach presents a daunting challenge to the development of an electronic medical record for medical rehabilitation. The initial results from the present study suggest that the task may not be quite as conceptually intimidating as first feared, although one should never underestimate the challenges of creating an electronic medical record.

Rehabilitation Research

The implications of intervention taxonomies for rehabilitation research are far reaching. They may help to standardize data collection on treatment interventions that will enable us to compare results across studies and across sites. Rehabilitation researchers have achieved a fairly high degree of standardization with respect to outcome measurement with the FIM instrument already an industry standard. Standardization on the input side will greatly strengthen our ability to make comparisons across an even wider range of interventions and outcomes.

In some investigations, the treatment administered may not be an independent variable, as in our stroke outcome study, but a dependent variable. For example, with a rehabilitation treatment taxonomy and measurement system, it becomes possible to examine the effects of independent variables such as organizational change (eg, hospital reorganization, new management information system) and health policy change (eg, new reporting systems, new payment systems) on the mix of services actually rendered. Front-line clinicians often assert that external changes adversely alter their daily practice patterns, but the ability to document these changes in lacking. A rehabilitation taxonomy and measurement system may enable us, for the first time, to quantify what changes really happen in the clinical setting when structural changes are imposed from the outside. It may enable us to eliminate our reliance on time-and-motion studies, billing office data, and other surrogate measures—that many find lacking—for what happens in the clinical setting.

CONCLUSIONS

Our approach to developing a study-specific rehabilitation taxonomy suggests that an inductive or bottoms-up approach is a promising, but not fully tested, way to develop a comprehensive rehabilitation taxonomy. The development of rehabilitation intervention taxonomies is currently in its infancy and promises to grow into a more mature intellectual and research enterprise in the years ahead. As the rehabilitation research community embarks in this area of research, we hope that our experiences in the present study may help inform the options for future research and development in rehabilitation intervention taxonomy.

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