

Model Formulation ■

Representing Nursing Activities within a Concept-oriented Terminological System: Evaluation of a Type Definition

SUZANNE BAKKEN, RN, DNSc, MARGARET S. CASHEN, RN, MS,
ENEIDA A. MENDONCA, MD, MSc, ANN O'BRIEN, RN, MS, JOAN ZIENIEWICZ, RN, BA

Abstract **Objective:** A type definition, as a component of the categorical structures of a concept-oriented terminology, must support nonambiguous concept representations and, consequently, comparisons of data that are represented using different terminologies. The purpose of the study was to evaluate the adequacy and utility of a proposed type definition for nursing activity concepts.

Design: Nursing activity terms ($n = 1039$) from patient charts and intervention terms from two nursing terminologies (Home Health Care Classification and Omaha System) were decomposed into the attributes of the proposed type definition—Delivery Mode, Activity Focus, and Recipient.

Measurements: Attributes of the type definition were coded as present or absent for each term by multiple raters. In addition, Delivery Mode was rated as Explicit or Implicit and Recipient was rated as Explicit, Implicit, or Ambiguous. The data were summarized using descriptive statistics. Inter-rater reliabilities were calculated for each attribute of the type definition.

Results: All attributes of the type definition were present in 73.9 percent of the chart terms, 91.3 percent of Home Health Care Classification intervention terms, and 63.5 percent of Omaha System intervention terms. While Delivery Mode and Activity Focus were almost universally present, Recipient was problematic. It was rated as ambiguous in 4.8 percent of the chart terms, 8.7 percent of Home Health Care Classification intervention terms, and 36.5 percent of Omaha System intervention terms.

Conclusions: The study findings supported the adequacy and utility of the type definition. Further research is needed to refine the type definition and its use for representing nursing activity concepts within a concept-oriented terminological system.

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Affiliations of the authors: University of California—San Francisco, San Francisco, California (SB, MSC); Columbia University, New York, New York (EAM, JZ); Stanford Health Care, San Francisco and Stanford, California (AO'B).

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Correspondence and reprints: Suzanne Bakken, RN, DNSc, Box 0608, University of California—San Francisco, San Francisco, CA; e-mail: (suh7001@flux.cpmc.columbia.edu).

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In recent years, the information demands of the health care environment and the dissemination of information technology in health care have highlighted the need for concept-oriented terminologies that can support rich descriptions of clinical encounters, data reuse, and data comparisons across heterogeneous representations.^{1,2} Such concept-oriented terminologies have been called *reference terminologies* in contrast to terminologies optimized for other purposes, such as end-user utilization (interface terminology) or statistical classification (administrative terminology).³

Extensive development of standardized terminologies that include nursing concepts has occurred during the

Table 1 ■

Terminologies for Representing Nursing Concepts

Terminology	Problems/Diagnoses	Goals	Interventions	Outcomes
Home Health Care Classification	✓		✓	✓
International Classification of Nursing Practice	✓		✓	✓
National Health Service (NHS) Clinical Terms (Read Codes)	✓		✓	
North American Nursing Diagnosis Taxonomy I	✓			
Nursing Interventions Classification			✓	
Nursing Outcomes Classification				✓
Omaha System	✓		✓	✓
Patient Care Data Set	✓	✓	✓	
Perioperative Nursing Data Set	✓		✓	✓
SNOMED RT	✓		✓	

last 25 years (Table 1).^{3–13} Nursing terminologies are typically implemented as both interface terminologies at the point of care and administrative terminologies to examine nursing data across settings, but currently no reference terminology exists that supports representation of a broad array of nursing concepts. This would not present a tremendous problem if the following were true: 1) a single uniform language existed; 2) the uniform language contained every term that a clinician would ever want to use at an appropriate level of granularity; 3) the uniform language was universally used by everyone; and 4) the uniform language could be manipulated by the computer for multiple purposes including decision support, billing, and aggregate analyses. This is obviously not the case!

A number of issues have hampered the implementation of nursing terminologies in computer-based systems in a manner that supports data re-use and comparisons across heterogeneous representations. First, although some might wish for a single terminology with broad coverage of the health care domain, it is clear that in the near future multiple terminologies will continue to exist.¹⁴ Second, the acceptance of standardized nursing terminologies continues to grow, but their use is not yet universal.¹⁵ Third, nurses routinely use terms other than those in standardized nursing terminologies in the care documentation process.^{16,17} Fourth, no single existing terminology can serve all purposes equally well; the level of granularity of data required for decision support is very different than that required for billing or for examining disease patterns in a population over time.^{1,2} Fifth,

studies have documented that no existing standardized nursing terminology meets the evolving criteria for terminologies related to suitability for implementation in and manipulation by computer-based systems.^{18,19}

Table 2 ■

Evaluation Criteria for Terminologies Related to Suitability for Implementation in and Manipulation by Computer-based Systems

Atomic-based—concepts must be separable into constituent components ²¹
Compositionality—ability to combine simple concepts into composite concepts, e.g., Pain and acute = acute pain ²¹
Concept permanence—once a concept is defined, it should not be deleted from a terminology ²²
Language independence—support for multiple linguistic expressions ²¹
Multiple hierarchy—accessibility of concepts through all reasonable hierarchical paths with consistency of views ^{20–22}
Nonambiguity—explicit definition for each term, e.g., patient teaching related to medication adherence defined as an activity with <i>delivery mode</i> of teaching, <i>care recipient</i> of patient, and <i>focus</i> of medication adherence ^{20–22}
Nonredundancy—one preferred way of representing a concept or idea ^{20–22}
Synonymy—support for synonyms and consistent mapping of synonyms within and among terminologies ^{20–22}

The last issue is of critical importance and is the primary motivation for the research presented in this article. Criteria developed by standards development organizations and individual authors indicate that, to facilitate computer-based terminology management and data re-use, terminologies must be concept-oriented (Table 2).^{20–23} What does it mean for a terminology to be concept-oriented? The basis for the answer to this question is an understanding of the definitions of and relationships among things in the world (objects), the thoughts about things in the world (concepts), and the labels (terms) used to represent the thoughts about things in the world; these relationships are commonly referred to as the semiotic triangle.²⁴ Standard 1087²⁵ of the International Organization for Standardization (ISO) provides the following definitions for the vertices of this triangle:

- *Concept*: a unit of thought constituted through abstraction on the basis of properties common to a set of objects
- *Object*: any part of the perceivable or conceivable world
- *Term*: designation of a defined concept in a special language by a linguistic expression

Thus, following from these definitions, a single concept may be associated with multiple terms (synonymy), but a term should represent only one concept (nonambiguity). The word *terminology*, defined as the set of terms representing a system of concepts, will be used throughout this article. More specifically, the phrase *concept-oriented terminology* is used to refer to a terminology in which the concepts are formally defined (e.g., using description logic) in a manner that renders them suitable for computer processing.

Formal Concept Representations

To compare data that have been represented in different ways (i.e., with different terms), terminologies designed for human understanding (i.e., sets of verbal or written terms) must be transformed to formal concept representations. The following components, specified by the European Committee for Standardization, are necessary to create formal concept representations: sets of terms, categorical structures (i.e., set of concepts and relationships), representation language, and tools for managing and manipulating the concepts.^{23,26} The focus of this article is on the second component, categorical structures; more specifically, on the evaluation of a type definition for nursing activity con-

cepts. As background, the status of the other three components relative to the domain of nursing is briefly summarized.

Sets of Terms

The development of nursing terminologies has occurred from the perspective of identifying, naming, and classifying the phenomena of the domain with a particular emphasis on nursing diagnoses, nursing interventions, and nursing-sensitive outcomes of care. This has occurred in the context of an increase in the number of doctorally prepared nurses and the growth of nursing research. Terminology development has been motivated by multiple factors, including the implementation of computer-based systems in clinical settings, the quest for reimbursement for nursing services, documentation of nursing contributions to patient care outcomes, the teaching of students, and the desire to enhance the body of nursing knowledge. Not surprisingly, given the motivating factors, emphasis has been primarily on developing the terms and not on the other components of concept representations, which fall more within the realm of information science or computer science. Nurse scientists have produced sets of terms that validly and reliably name and categorize nursing concepts.^{4–13} In addition, other health care terminologies include terms that research has shown to be useful for representing concepts of interest in nursing.^{16,17}

Representation Language and Tools

Description logic-based representation languages—e.g., Knowledge Representation Syntax (KRSS) and Galen Representation and Integration Language (GRAIL)—that are supported by suites of computer-based tools have been developed for the management and processing of concept-oriented terminologies with broad coverage of the health care domain.^{27–29} Recently, the applicability of description logics and tools for representing nursing concepts has been demonstrated in several environments.^{30,31} For example, concepts and relationships in SNOMED RT are represented using modified KRSS.²⁷ Concept definition and manipulation are supported through a set of tools with functionality such as acronym resolution, word completion, term completion, spelling correction, display of the authoritative form of the term entered by the user, and decomposition of unrecognized input (Metaphrase)³²; automated classification into multiple type hierarchies (Ontylog); and conflict management, detection, and resolution (Galapagos).²⁷ Figure 1 illustrates a modified KRSS representation of two nursing activities, using the relevant and currently allowable defining attributes for procedures in SNOMED RT.

- Teaching client about safe sex

```
(define-concept teaching client about safe sex
  (and procedure)
  (has object client)
  (has object safe sex)
  (uses technique teaching)))
```

- Assessing ability of family to cope

```
(define-concept assessing ability of family to cope
  (and procedure)
  (has object family)
  (has object coping ability)
  (uses technique assessing)))
```

Figure 1 Representation of nursing activity concepts using modified Knowledge Representation Syntax (KRSS) representation and defining attributes for procedures in SNOMED RT.

Categorical Structures

Categorical structures include the high-level semantic categories of concepts (hierarchic knowledge) that need to be defined and standardized from a terminological point of view and type definitions that state the essential properties or attributes of a concept, i.e., the attributes that *must* be specified for *every* concept of a particular type (nonhierarchic knowledge).^{26,33}

The terminology model comprises these categorical structures. For example, the high-level semantic categories related to the definition of a laboratory test in the Logical Observations Identifiers, Names, and Codes (LOINC)³⁴ terminology are Component, Property Measured, Timing, Type of Sample, Type of Scale, and Method Type. Within LOINC, type definitions are known as the required attributes of fully specified names; a laboratory test has the required attributes of Component, Property Measured, Timing, Type of Sample, and Type of Scale, but Method Type is optional. The values for the attributes are organized by the high-level semantic categories (i.e., the attributes). Values related to the attribute Type of Scale in LOINC are quantitative, ordinal, nominal, and narrative. The formal definition (fully specified name) of a specific laboratory test is the instantiation of the type definition attributes with the values.

Terminology models have been developed in several subdomains of medicine,^{35,36} and there have been a few reports of terminology models for nursing.^{30,31,37,38} Common across several terminology models for nursing (Table 3) and a point of distinction between the structure of nursing activity terms and the typical

physician procedure terms are the concepts of Recipient (e.g., client, caregiver, family, community), Delivery Mode (e.g., assess, teach) and Activity Focus (e.g., medication compliance). Despite the recent advances in developing terminology models for nursing, there has been no systematic evaluation of a type definition for nursing activities, i.e., definition of the necessary and sufficient attributes of a nursing activity concept. Lack of a broadly accepted type definition has hindered the nonambiguous representation of nursing concepts, the mapping among data represented with different nursing terminologies (see Zielstorff, et al.³⁹ for example), and the inclusion of nursing concepts in large description-logic-based health care terminologies.

Study Purpose

The purpose of the study was to evaluate the adequacy and utility of a proposed type definition for nursing activities. Two research questions were addressed:

- What percentage of nursing activity terms include the three attributes of the type definition (Delivery Mode, Activity Focus, and Recipient)?
- Can the nursing activity terms be reliably decomposed into the three attributes of the type definition?

Methods

Definitions

The type definition for nursing activity concepts tested in this study comprised three attributes—Delivery Mode, Activity Focus, and Recipient. The study terms were defined using the definitions from the model proposed by Warren et al.⁴⁰:

Table 3 ■

Comparison of Terminology Models for Representing Nursing Activities with Proposed Type Definition

Proposed Model	Attributes		
	Activity Focus	Delivery Mode	Recipient
Campbell and Warren ³⁸		Method	Recipient
CMT/SNOMED RT ⁴⁶	Object	Technique	Object
Henry and Mead ³⁷		Delivery Mode	Recipient
ICNP Beta ⁴⁷	Target	Action Type	Beneficiary

NOTE: CMT indicates Convergent Medical Technology.

- An *Activity* is an intentional service delivered by a provider to a recipient, e.g., wound care provided by a nurse, grief counseling provided to a family.
- The *Delivery Mode* is the manner in which the activity is applied to the recipient, e.g., assess the patient for shortness of breath, coordinate the delivery of Meals on Wheels, teach patient's family about medication schedule. All activities have a Delivery Mode.
- The *Activity Focus* is the phenomenon on which the activity is centered. An Activity Focus can be a medical or nursing diagnosis, sign, symptom, problem, or health issue (including prevention, promotion, and maintenance), e.g., pain, inadequate knowledge, blood pressure. All activities have an Activity Focus.
- The *Recipient* is the person, family, organization, or aggregate to whom the activity is delivered. The patient is the implicit recipient of all activities unless otherwise specified; e.g., "apply sterile dressings to wound" (patient is implicit); "teach the caretaker transferring precautions" (caretaker is explicit). All activities have a Recipient.

For the purposes of this evaluation, the category Ambiguous was added to the Recipient categories Implicit and Explicit. It was used to code instances in which, on consideration of the label (i.e., term) or description (in the standardized nursing terminologies) of the Activity Focus, the rater's judgment was that the Recipient could possibly be an individual acting in the role of a patient, an individual acting in another role (e.g., caretaker or parent), or an aggregate (e.g., family or institution). In other words, the assumption that the Recipient was implicitly the patient unless explicitly stated was questioned.

Data Sets

Three sets of data were used in the evaluation of the type definition: 1) nursing activity terms documented in the patient chart, 2) intervention terms from the Home Health Care Classification (HHCC), and 3) intervention terms from the Omaha System. The chart terms represent an interface terminology. The HHCC and Omaha System have been used in practice as both interface terminologies (for care documentation) and administrative terminologies (for aggregation and analysis).

Chart Terms

The data set of nursing activity terms from the patient charts comprised 1,039 nonredundant nursing activity terms from the health records of more than 300 pa-

tients hospitalized for an AIDS-related condition. The nursing activity terms were abstracted verbatim from patient charts as part of a longitudinal study linking patient problems, nursing interventions, and patient outcomes for persons receiving nursing care for HIV/AIDS.

Home Health Care Classification

The HHCC includes 161 intervention terms and four modifiers (Assess, Direct Care, Teach, Manage) that can be used with each intervention term (e.g., Breathing Exercises—Assess, Breathing Exercises—Direct Care, Breathing Exercises—Teach, Breathing Exercises—Manage) to fully specify a nursing service statement. For HHCC, nursing intervention is defined as "a single nursing action—treatment, procedure or activity—designed to achieve an outcome to a diagnosis—medical or nursing—for which the nurse is accountable." The modifiers are defined as follows:

- *Assess*: collect and analyze data on the health status
- *Direct Care*: perform a therapeutic action
- *Teach*: provide knowledge and skill
- *Manage*: coordinate and refer

Omaha

The Omaha System intervention scheme comprises four categories of activities (Health Teaching, Guidance, and Counseling; Treatments and Procedures; Case Management; and Surveillance) and 63 targets of action (e.g., Caretaking/Parenting Skills, Signs/Symptoms-Physical). The following definitions are provided for the four categories:

- *Health Teaching, Guidance, and Counseling* are nursing activities that range from giving information, anticipating client problems, encouraging client action and responsibility for self-care and coping, to assisting with decision making and problem solving. The overlapping concepts occur on a continuum with variation due to the client's self-direction capabilities.
- *Treatments and Procedures* are technical nursing activities directed toward preventing signs and symptoms, identifying risk factors and early signs and symptoms, and decreasing or alleviating signs and symptoms.
- *Case Management* includes nursing activities of coordination, advocacy, and referral. These activities involve facilitating service delivery on behalf of the client, communicating with health and human service providers, promoting assertive client commu-

nication, and guiding the client toward use of appropriate community resources.

- *Surveillance* includes nursing activities of detection, measurement, critical analysis, and monitoring to indicate client status in relation to a given condition or phenomenon.

The category and target of action are combined to create an intervention term (e.g., Skin Care—Surveillance, Bronchial Hygiene—Treatments and Procedures). It is not clear from the published Omaha System descriptions whether each category can be used with every target of action. The intervention scheme is used in conjunction with the problem scheme in which the care recipients of Family or Individual operate as problem modifiers.

Procedures

Each nursing activity term from the data sets was entered into an Access database and was decomposed into the three elements of the type definition by multiple raters. Delivery Mode was coded as Explicit or

Implicit. Recipient was categorized as Explicit, Implicit, or Ambiguous. Terms were coded as including the three essential properties of the type definition if they included an Explicit Delivery Mode, an Activity Focus, and a nonambiguous Recipient (i.e., either Explicit or Implicit). For HHCC and Omaha, the raters considered the textual definitions of the interventions as well as the intervention labels or terms during the decomposition process. One rater (S.B.) served as the gold standard. Additional raters were trained using a subset of terms from the relevant data set until interrater reliability reached 95 percent agreement. Examples of nursing activity terms and their associated decompositions are shown in Table 4.

Results

First Research Question

We first sought to determine what percentage of nursing activity terms include the three attributes of the type definition (Delivery Mode, Activity Focus, and Recipient).

Table 4 ■

Examples of Chart Terms, Home Health Care Classification (HHCC) Intervention Terms, and Omaha System Intervention Terms Decomposed into Elements of the Type Definition

Activity/Intervention	Delivery Mode	Activity Focus	Recipient
Chart Terms:			
Assess family knowledge level	Assess	Knowledge level	Family
Assist with ambulation	Assist	Ambulation	Patient (implicit)
Call house officer for T > 38	Call	T > 38	House officer
Oxygen administration	Administer	Oxygen	Patient (implicit)
Teach friend to do dressing change	Teach	Dressing change	Friend
Oxygen oximetry qam	Ambiguous—perform and/or monitor	Oxygen oximetry	Patient (implicit)
Notified MD	Notified		MD
Provide accurate information about AIDS.	Provide	Accurate information about AIDS	Ambiguous—patient or family
HHCC Intervention Terms:			
Blood Pressure—Assess	Assess	Blood pressure	Patient (implicit)
Coping Support—Teach	Teach	Coping support	Ambiguous—patient or family
Individual Safety—Manage	Manage	Individual safety	Individual
Medication Administration—Direct Care	Direct care	Medication administration	Patient (implicit)
Omaha Intervention Terms:			
Medication Administration—Treatments and Procedures	Treatment and procedures	Medication administration	Patient (implicit)
Caretaking/Parenting Skills—Health Teaching, Guidance and Counseling	Health teaching, guidance and counseling	Caretaking/parenting skills	Caretaker/patient
Screening—Surveillance	Surveillance	Screening	Ambiguous
Legal System—Case Management	Case management	Legal system	Ambiguous

Table 5 ■

Frequencies of Attributes of Type Definition Identified in Chart Terms, Home Health Care Classification (HHCC) Intervention Terms, and Omaha System Intervention Terms

Element of Type Definition	Chart		HHCC		Omaha	
	N	Percent	N	Percent	N	Percent
Delivery Mode:						
Explicit	852	82.0	161	100.0	63	100.0
Implicit	187	18.0	0	0.0	0	0.0
Absent	0	0.0	0	0.0	0	0.0
Inter-rater reliability:						
Gold standard vs. Raters 2 & 3		94.4				
Gold standard vs. Rater 4				100.0		
Gold standard vs. Rater 5						100.0
Activity Focus:						
Present	988	95.1	161	100.0	63	100.0
Absent	51	4.9	0	0.0	0	0.0
Inter-rater reliability:						
Gold standard vs. Raters 2 and 3		98.7				
Gold standard vs. Rater 4				100.0		
Gold standard vs. Rater 5						100.0
Recipient:						
Explicit	200	19.2	21	13.0	1	1.6
Implicit	789	75.9	126	78.3	39	61.9
Ambiguous	50	4.8	14	8.7	23	36.5
Inter-rater reliability:						
Gold standard vs. Raters 2 and 3		94.0				
Gold standard vs. Rater 4				88.2		
Gold standard vs. Rater 5						68.9

NOTE: Frequencies and percentages in the table are those of the gold standard.

Chart Terms

For the data set of chart terms, the three essential properties of the type definition were included in 73.9 percent of the nursing activity terms. If the criterion for containing all three properties had allowed Implicit Delivery Mode, the percentage of terms considered complete would have increased to more than 90 percent. The frequencies with which the nursing activity terms could be decomposed into the elements of the type definition are summarized in Table 5. Eighty-two percent of the nursing activity terms had explicit Delivery Modes. Two different types of terms did not have explicit Delivery Modes. For the first type, represented by Respiratory Isolation and Ambulation, an implicit direct care Delivery Mode (e.g., maintain, and assist with, respectively) was consistently posited by the three raters. Oxygen Oximetry, Weight, and Vital Signs represent terms that did not have explicit Delivery Modes and were coded as perform (a type of direct care Delivery Mode) and/or monitor (a type of assessment Delivery Mode) by the three raters. The majority (95.1 percent) of the terms had an Activity Focus. Notified MD and Explained to Patient are examples of terms for which no Activity

Focus was identified. Of particular note were terms such as Ambulate and Medicate that were alternatively coded by the raters as Delivery Mode or as Activity Focus with an implicit Delivery Mode, e.g., Assist with Ambulation and Administer Medication. Recipient was identified as Explicit in 19.2 percent, Implicit in 75.9 percent, and Ambiguous in 4.8 percent.

Home Health Care Classification

The HHCC modifier was determined to be equivalent to Delivery Mode in the proposed type definition; thus, 100 percent of the interventions had a Delivery Mode (Table 5). Similarly, the intervention term without the qualifier was determined to be synonymous with Activity Focus. Recipient was coded as Implicit in 78.3 percent, Explicit in 13.0 percent, and Ambiguous in 8.7 percent. The percentage of HHCC interventions containing the three elements of the type definition was 91.3 percent.

Omaha

For the Omaha System, category was determined to be equivalent to Delivery Mode and target of action equivalent to Activity Focus; thus, Delivery Mode and

Activity Focus were coded as present for all interventions. Recipient was coded as Implicit in 61.9 percent, Explicit in 1.6 percent, and Ambiguous in 36.5 percent. The percentage of Omaha intervention terms containing the three elements of the type definition was 63.5 percent.

Second Research Question

In the second part of the study, we sought to determine whether the nursing activity terms can be reliably decomposed into the three attributes of the type definition.

Inter-rater reliability was assessed using percent agreement among the multiple raters (Table 5). A total of five raters participated. For the data set of chart terms, percent agreement between the gold standard (Rater 1) and the other raters was 91.5 percent and 96.2 percent for Delivery Mode. The percent agreement between Rater 2 and Rater 3 was 93.2 percent. For Activity Focus, there were 14 instances in which Rater 2 or Rater 3 identified an Activity Focus when the gold standard did not. For example, MD Notified was decomposed with Perform as the implied Delivery Mode, Notification as the Activity Focus. Similarly, Ambulation BID was coded with Assist as the implied Delivery Mode and Ambulation as the Activity Focus. Raters 1 and 2 disagreed with the gold standard on the Recipient for 6 percent of the terms. With a few exceptions, this occurred when the gold standard identified the Recipient as ambiguous and the other raters stated that the patient was the implied Recipient. For HHCC, percent agreement between the two raters (gold standard and Rater 4) was 88.2 percent for Recipient. Because qualifier and intervention were considered synonymous with Delivery Mode and Activity Focus respectively, agreement was 100 percent for the two elements. This was also true for the Omaha. For Recipient, inter-rater reliability was 68.9 percent. The disagreements between the two raters occurred primarily when the gold standard coded the Recipient as implicit and Rater 5 coded the Recipient as ambiguous, because in her judgment the family was also considered a potential Recipient of the activity.

Discussion

A type definition, as a component of the categorical structures of a concept-oriented (i.e., reference) terminology, must support nonambiguous concept representations and, consequently, comparisons of data represented using different terminologies (e.g., interface and administrative; administrative and administrative). In this study, three data sets representing in-

terface and administrative terminologies were decomposed against the proposed type definition. The findings showed that the majority (73.9 percent) of nursing activity terms in the data set of chart terms (interface terms) contained the three properties of the type definition (Activity Focus, Delivery Mode, and Explicit or Implicit Recipient). In addition, the terms were reliably decomposed into the attributes of the type definition by the three nurse raters. Of note, the inter-rater reliability for the Recipient was acceptable (94 percent) even though Recipient was implicit in 75.9 percent of the nursing activity terms. Other analyses provided evidence that the type definition had utility as a model against which the HHCC and Omaha terms could be decomposed; 91.3 percent of HHCC intervention terms and 63.5 percent of Omaha intervention terms contained the three elements of the type definition. The structure of these systems made identification of the Activity Focus and Delivery Mode a straightforward and reproducible process. On the other hand, the Recipient was more frequently identified as Ambiguous in the HHCC (8.7 percent) and Omaha (36.5 percent) terms than in the chart terms (4.8 percent). Concomitantly, the inter-rater reliability was also lower. The findings related to Recipient do not necessarily mean that the type definition is inadequate or that it does not have utility. An alternative explanation is that it is important to explicitly model the recipient of the nursing intervention, since many interventions can be applied to either the individual client, another individual (e.g., caregiver), the family, or another aggregate. The implication of this explanation is that if an intervention has a different recipient, it is a different concept, e.g., teaching an individual client about diabetic foot care is a different concept than teaching a family caregiver about diabetic foot care. Others might argue that the concepts of teaching a family or teaching an individual are not inherently different and that the Recipient should be captured in the information model, not as a defining attribute of a nursing activity concept.

The data sets chosen to evaluate the type definition were limited to one set of chart terms and two nursing terminologies. Chart terms from another type of clinical population might include other nursing activity concepts that would not decompose to the type definition as well as those in the sample. Among the seven terminologies that include nursing intervention terms and are recognized by the American Nurses Association, the HHCC and Omaha System were selected as the terminologies to test the type definition for two reasons. First, as compared with precoordinated terminologies such as the Nursing Interventions Classification⁶ and the Patient Care Data Set,⁴¹ the HHCC and Omaha include compositional structures

that are combined to represent a particular nursing intervention concept. Thus, the decomposition could be done in a manner that maintained the integrity of the internal structures of the systems. Second, as terminologies in the public domain, the HHCC and Omaha are more readily available for convergence into concept-oriented terminologies for the domain of health care than are proprietary terminologies. However, the type definition must be tested with other terminologies to ensure its adequacy.

In addition, for the analyses of HHCC and Omaha, every word in the nursing activity terms fit the attributes of the type definition. This was not true of the chart terms. For example, terms included attributes such as frequency or dose of intervention (e.g., QID, q2h) or temporal constraints (e.g., postoperatively, within two hours of admission) that were not part of the proposed type definition. Prior research provides evidence that some nursing activities include additional attributes, such as provider, equipment/resources, sites, techniques, and means.³¹ Whether these attributes are part of the type definition or, alternatively, belong in an information model needs exploration and testing.

Conclusions

The developers of nursing and health-related terminologies and informatics scientists have made significant progress toward achievement of a concept-oriented terminological system for nursing concept representation. Nurse scientists have developed sets of reliable and valid terms. The applicability of representation languages and tools has been demonstrated for the domain of nursing. A major remaining challenge is the development and dissemination of a terminology model for nursing. There is significant progress in that area as well. The existing nursing terminologies are an excellent source of concepts for inclusion as categorical structures in terminology models. In addition, a number of efforts within health care (e.g., Health Level 7, SNOMED RT) are aimed at the achievement of a concept-oriented terminological system that supports semantic interoperability across health care information systems.⁴² Beyond the work of individual investigators, ongoing efforts related to categorical structures for nursing concepts include the International Classification of Nursing Practice project from the International Council of Nursing,⁴³ Galen,³¹ nursing work related to CEN ENV 12264,⁴⁴ the work plans resulting from the 1999 Nursing Vocabulary Summit Conference,⁴⁵ and the Convergent Terminology Group for Nursing within SNOMED RT. Concept-oriented terminologies are a prerequisite for meeting

the information demands of today's complex health care environment and for documenting nursing contributions to health care outcomes.

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