Model Formulation ■

Integrating Nursing Diagnostic Concepts into the Medical Entities Dictionary Using the ISO Reference Terminology Model for Nursing Diagnosis

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Abstract **Objective:** The purposes of the study were (1) to evaluate the usefulness of the International Standards Organization (ISO) Reference Terminology Model for Nursing Diagnoses as a terminology model for defining nursing diagnostic concepts in the Medical Entities Dictionary (MED) and (2) to create the additional hierarchical structures required for integration of nursing diagnostic concepts into the MED.

Design and Measurements: The authors dissected nursing diagnostic terms from two source terminologies (Home Health Care Classification and the Omaha System) into the semantic categories of the ISO model. Consistent with the ISO model, they selected Focus and Judgment as required semantic categories for creating intensional definitions of nursing diagnostic concepts in the MED. Because the MED does not include Focus and Judgment hierarchies, the authors developed them to define the nursing diagnostic concepts.

Results: The ISO model was sufficient for dissecting the source terminologies into atomic terms. The authors identified 162 unique focus concepts from the 266 nursing diagnosis terms for inclusion in the Focus hierarchy. For the Judgment hierarchy, the authors precoordinated Judgment and Potentiality instead of using Potentiality as a qualifier of Judgment as in the ISO model. Impairment and Alteration were the most frequently occurring judgments.

Conclusions: Nursing care represents a large proportion of health care activities; thus, it is vital that terms used by nurses are integrated into concept-oriented terminologies that provide broad coverage for the domain of health care. This study supports the utility of the ISO Reference Terminology Model for Nursing Diagnoses as a facilitator for the integration process.

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Multiple nursing terminologies exist, and no single terminology currently provides comprehensive coverage for the domain of nursing.[1–4] In recent years, nursing efforts have shifted from simply mapping between the terms in two terminologies toward the creation of concept-oriented terminologies in which the concepts from each nursing terminology are integrated into a reference terminology.[5–7] Studies outside the domain of nursing have shown the impact of reference terminologies not only on terminology

management, but also on data sharing and reuse, decision support, and accuracy of information retrieval.[8–10]

Whether the goal is creating a nursing reference terminology (e.g., Hardiker's nursing intervention reference terminology[11]) or the integration of nursing concepts into a concept-oriented health care terminology (e.g., SNOMED CT[12] or the Medical Entities Dictionary[9]), a terminology model that specifies the manner in which atomic terms are combined to intentionally define molecular term phrases from source terminologies is needed.[13,14] Recently, terminology models that support nursing concepts have been proposed and tested.[15–20]

Prominent among these are international efforts such as the International Classification of Nursing Practice (ICNP),[21] Telenurse, the European Committee for Standardization's work on systems of concepts for nursing, and, most recently, the International Standards Organization (ISO) efforts to develop reference terminology models for nursing diagnoses and actions. In addition, the Nursing Terminology

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Summit, an international collaboration of terminology developers, and informatics and standards experts, has facilitated model development and testing and motivated cooperation and convergence among nursing terminology developers and with other standards efforts.[5]

As part of a larger effort to add nursing concepts to a concept-oriented terminology in a manner consistent with evolving terminology standards, the purposes of this study were (1) to evaluate the usefulness of the ISO Reference Terminology Model for Nursing Diagnoses as a terminology model for defining nursing diagnostic concepts in the Medical Entities Dictionary (MED) and (2) to develop the additional hierarchical structures required for integration of nursing diagnostic concepts into the MED.

Target Terminology

The MED is a concept-oriented terminology that serves as the institutional data dictionary at New York Presbyterian Hospital.[9] The MED is a semantic network that implements multiple hierarchies. Each node in the network is a concept in the MED that is viewed as a slot-based frame. The slots and their values, if any, are the defining properties of the concept. There are two types of slots: string slots whose value is intrinsic to the concept (e.g., its preferred name) and semantic slots that relate a concept to other concepts in the dictionary (e.g., *Knowledge Deficit* has Subject of Information *Patient*).

Each slot has a unique origination point at a specific MED concept. All descendants of the concept inherit the slot. Software tools have been developed that allow the semantic network to be edited consistently. For example, the editing tools allow a slot's origination point to be moved easily, subject to certain restrictions. Of particular importance when adding new concepts to the MED, an origination point can always be moved to a more general concept without affecting any slot values already instantiated in descendants.[22]

Source Terminologies

A nursing diagnosis is "a clinical judgment about individual, family, or community responses to actual or potential health problems/life processes. Nursing diagnoses provide the basis for selection of nursing interventions to achieve outcomes for which the nurse is accountable."[23] Six terminologies that include nursing diagnostic concepts have been recognized by the American Nurses Association: the Home Health Care Classification (HHCC), the International Classification of Nursing Practice (ICNP), the North American Nursing Diagnosis Association (NANDA), the Omaha System, the Patient Care Data Set, and the PeriOperative Nursing Data Set.[24] We selected HHCC and the Omaha System for our analysis because they were research-based, in the public domain, registered for use in Health Level 7 messages, and represented two different approaches to characterizing patient or family problems commonly addressed by nurses. In addition, the Omaha

Problem Rating Scale and HHCC Expected Outcomes were already integrated into the MED using the Logical Observation Identifiers, Names, and Codes (LOINC) semantic model.[22]

Home Health Care Classification

HHCC is designed to provide a framework for documenting and classifying home health and ambulatory care.[23] HHCC consists of two interrelated terminologies: the HHCC of Nursing Diagnoses and the HHCC of Nursing Interventions. These two terminologies use a framework of 20 Care Components that represent the functional, health behavioral, physiologic, and psychological patterns of patient care. HHCC has 146 nursing diagnoses. The diagnoses are based on NANDA and also include additional diagnoses specific to home care.

Omaha System

The Omaha System includes the Problem Classification Scheme, Intervention Scheme, and Outcome Model (i.e., Problem Rating Scale). The Problem Classification Scheme consists of 40 client problems organized into four domains: environmental (4 problems), psychosocial (12 problems), physiological (15 problems), and health-related behavioral (9 problems). Because each problem can be qualified as actual, potential, or health promotion, our data set for analysis included a total of 120 problems (40 × 3).[25]
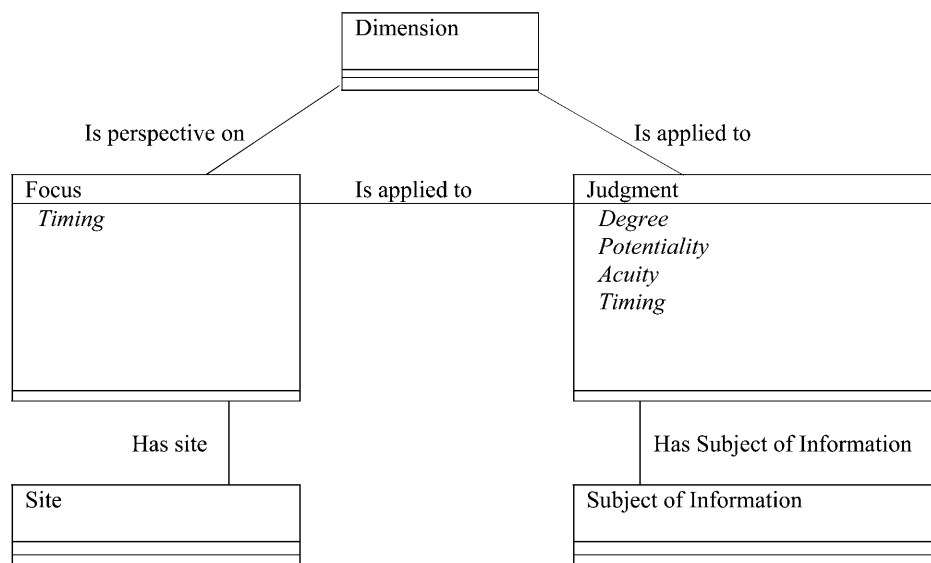
Reference Terminology Model

We selected the International Standards Organization (ISO) reference terminology model for nursing diagnoses for our analysis because of its international relevance and the fact that it builds on prior models (e.g., the categorical structure proposed by the European Standardization Committee) that have been evaluated extensively.[26,27] The ISO model was developed under the auspices of the International Council of Nurses and the Nursing Special Interest Group of the International Medical Informatics Association; refinement is continuing through the ISO process toward an international standard.

In the ISO model, a nursing diagnosis is considered either as a Judgment on a Focus or as a Judgment on a particular Dimension of a Focus (Fig 1). Judgment and Focus are mandatory semantic categories. A descriptor for Subject of Information (e.g., bearer of the diagnosis) is used as necessary to disambiguate similar-term phrases in a terminology (e.g., family coping impairment vs. individual coping impairment).

Methods

Three steps were required as prerequisites for integrating nursing diagnostic concepts into the MED: (1) dissection of the nursing diagnosis terms using the ISO model, (2) selection of the semantic categories of the ISO model that would be precoordinated vs. postcoordinated in the MED,

Figure 1. ISO Reference terminology model for nursing diagnoses. Focus = area of attention; Dimension = quality possessed by an "individual" or "group," e.g., knowledge, motivation, ability; Judgment = opinion or discernment related to a focus or dimension; Degree = scale of gradations, e.g., very, mild, extreme; Potentiality = possibility, e.g., risk for, actual, possibility of, potential; Acuity = duration, e.g., acute, chronic; Timing = a point or period in time, e.g., during a procedure, perinatal, postoperative; Site = physical structure that further specifies the position of a focus or a target; Subject of Information = entity to which a diagnosis refers.

and (3) development of the necessary hierarchies. The terms were dissected by one author and then reviewed by a second author who was experienced with the terminologies and the ISO model. Differences were resolved through discussion between the two raters. The hierarchies were derived initially by one author and then reviewed by two authors experienced in the development of concept-oriented terminologies.

Dissection of the Nursing Diagnoses Using the ISO Model

We entered the nursing diagnosis term phrases from HHCC and Omaha into a Microsoft Access database and dissected them into the relevant semantic categories of the ISO model. For example:

Activities of daily living (ADLs) alteration
   Focus: ACTIVITIES OF DAILY LIVING
   Judgment: ALTERATION
      Potentiality: ACTUAL
   Subject of Information: INDIVIDUAL
Spiritual distress: Actual
   Focus: SPIRITUAL STATE
   Judgment: DISTRESS
      Potentiality: ACTUAL
   Subject of Information: INDIVIDUAL

Selection of the Semantic Categories of the ISO Model for Precoordination vs. Postcoordination in the MED

Consistent with the ISO model, we selected Focus and Judgment as required semantic categories for creating

intensional definitions of nursing diagnostic concepts in the MED. We decided to precoordinate Dimension and Focus. For example, in the term phrase "Knowledge Deficit of Diagnostic Test," we did not separate out "Knowledge" as a Dimension of *"Diagnostic Test."* Instead, we considered *"Knowledge of Diagnostic Test"* as the Focus and *"Deficit"* as the Judgment. The rationale for this decision was that our previous experience with the semantic category of Dimension suggested that it was not possible to achieve sufficient intercoder reliability of the dissections and also that the majority of nursing diagnoses do not include a dimension.[28] Moreover, we decided that for the purposes of integrating HHCC and Omaha into the MED, the semantics of the diagnostic concepts were modeled sufficiently without the category of Dimension.

For consistency, we converted foci into noun form, e.g., "grieving" to "grief." We defined Subject of Information only when it was necessary to disambiguate the term phrases in the source terminologies, e.g., individual coping impairment vs. family coping impairment.

Creation of Necessary Hierarchies

Within the MED, nursing diagnosis concepts (like medical diagnosis concepts) are classified under Intellectual Product. Because the MED did not include hierarchies for Judgment and Focus, the two required semantic categories in the ISO model, we needed to create these hierarchies to define the nursing diagnostic concepts. We derived the initial hierarchies from an examination of the concepts that we dissected into the Judgment and Focus semantic categories of the ISO model. We refined the hierarchies based on review of the diagnostic-related hierarchies of the ICNP and NANDA Taxonomy II.[21,28]

Results

Dissection of the Nursing Diagnoses Using the ISO Model

We dissected 266 nursing diagnoses, including 146 HHCC and 120 Omaha diagnoses, into the semantic categories of the ISO model. All diagnoses included the categories of Focus, Judgment, Subject of Information (either implicit or explicit), and the Judgment attribute of Potentiality (either implicit or explicit). In 39 nursing diagnoses, a single term (e.g., pain) represented both Focus and Judgment. We included such terms in Focus for consistency of modeling and for ease of adding other qualifiers to the particular term (e.g., acute pain; see Appendix A online at www.jamia.org).

Focus Hierarchy

We identified 162 unique focus concepts for inclusion in the Focus hierarchy. To classify the foci of conjunctive term phrases from HHCC and Omaha, we converted "AND," "/", and "-" into "and/or." Examples include "digestion and/or hydration" instead of "digestion-hydration" and "sleep and/or rest patterns" instead of "sleep and rest patterns." We did not include terms such as "body" and "human," e.g., "body nutrition" and "human sexuality" because they were not needed to disambiguate the meaning of the term (Table 1).

Judgment Hierarchy

The two source terminologies included three main categories of Judgments; thus, we created three categories at the top of the Judgment hierarchy: Actual, Potential, and Health Promotion (Table 2). Although in some instances, such as in NANDA, health promotion is considered a process, in the Omaha System it is defined as quite similar to client status as reflected in other judgments (e.g., impairment): "client interest in increasing knowledge, behavior, and health expectations as well as developing resources that maintain or enhance well-being in the absence of risk factors, signs, or symptoms."[25] This approach reflects our decision to precoordinate Judgment and Potentiality instead of using Potentiality as a qualifier of Judgment (e.g., Potential Alteration compared with Alteration has potentiality Potential) as in the ISO model. This decision raises the issue of combinatorial explosion; however, given the relatively small number of terms, we felt that the pragmatic benefits of precoordination for integrating diagnostic concepts into the MED outweighed the risk. Consistent with ISO, we left Degree, Timing, and Acuity as qualifiers of Judgment rather than incorporate them into the Judgment hierarchy.

Impairment ($n = 45$) and Alteration ($n = 44$) were the most frequently occurring Judgments, whereas Potential Impairment ($n = 31$) occurred most frequently for the category of Potential. There were 43 nursing diagnoses having only Actual as an implied Judgment without further refinement: 39 HHCC diagnoses and four Omaha diagnoses (e.g.,

Table 1 ∎ Frequency (F_q) of Concepts in the Focus Hierarchy

Focus	Fq
Abused child and/or adult	3
Activity	3
Disuse syndrome	1
Diversional activity	1
Fatigue	1
Physical activity	3
Physical mobility	1
Self-care	1
Activities of daily living	1
Bathing and/or hygiene	1
Personal hygiene	3
Dressing and/or grooming	1
Feeding	1
IADLs	1
Toileting	1
Sleep and/or rest patterns	3
Sleep pattern	1
Antepartum and/or postpartum	3
Bowel elimination	1
Bowel function	3
Bowel incontinence	1
Colonic constipation	1
Diarrhea	1
Fecal impaction	1
Perceived constipation	1
Unspecified constipation	1
Circulation	3
Blood pressure	1
Cardiac output	1
Cardiovascular function	1
Peripheral vascularization	1
Tissue perfusion	1
Cognition	3
Cerebral function	1
Consciousness	3
Knowledge	1
Knowledge of diagnostic test	1
Knowledge of dietary regimen	1
Knowledge of disease process	1
Knowledge of fluid volume	1
Knowledge of medication regimen	1
Knowledge of safety precautions	1
Knowledge of therapeutic regimen	1
Thought processes	1
Comfort	1
Pain	5
Unspecified pain	1
Communication	1
Communication with community resources	3
Compliance	1
Compliance with diagnostic test	1
Compliance with dietary regimen	1
Compliance with safety precautions	1
Compliance with therapeutic regimen	1
Compliance with fluid volume	1
Compliance with medication regimen	1
Coping	4
Adjustment	1
Decision	1
Defensive coping	1
Denial	1
Dying process	1

Table 1 ▪ Continued

Focus	Fq
Posttrauma response	1
Rape trauma syndrome	1
Dentition	3
Digestion and/or hydration	3
Fluid volume	5
Gastrointestinal function	1
Swallowing	1
Emotional stability	3
Anxiety	1
Fear	1
Grief	5
Anticipatory grieving	1
Endocrine	1
Family processes	1
Caretaking and/or parenting	3
Neglected child and/or adult	3
Parenting	1
Breastfeeding	1
Family planning	3
Genitourinary function	3
Growth and/or development	4
Health-seeking behavior	1
Health care supervision	3
Health maintenance	1
Medication	1
Polypharmacy	1
Prescribed medication regimen	3
Substance use	3
Technical procedure	3
Home maintenance	1
Immunologic function	1
Protection	1
Income	3
Infection	1
Unspecified infection	1
Injury	1
Integument	3
Mucous membranes	1
Skin	1
Skin integrity	2
Tissue integrity	1
Musculoskeletal function	1
Neighborhood and/or workplace safety	3
Neuromusculoskeletal function	3
Nutrition	8
Physical regulation	1
Dysreflexia	1
Poisoning	1
Residence	3
Respiration	4
Airway clearance	1
Aspiration	1
Breathing pattern	1
Gas exchange	1
Role performance	1
Parental role	1
Role change	3
Sanitation	3
Self-concept	1
Body image	1
Hopelessness	1
Meaningfulness	1
Personal identity	1
Powerlessness	1

Continued

Table 1 ▪ Continued

Focus	Fq
Self-esteem	1
Situational self-esteem	1
Sensory perceptual function	1
Auditory function	1
Hearing	3
Gustatory function	1
Kinesthetic function	1
Olfactory function	1
Tactile function	1
Unilateral neglect	1
Vision	4
Sexuality	3
Sexual function	1
Sexuality patterns	1
Social interaction	1
Interpersonal relationship	3
Social contact	3
Social isolation	1
Socialization	1
Spiritual state	5
Suffocation	1
Thermoregulation	1
Hyperthermia	1
Hypothermia	1
Trauma	1
Urinary elimination	1
Functional urinary incontinence	1
Reflex urinary incontinence	1
Renal function	1
Stress urinary incontinence	1
Total urinary incontinence	1
Urge urinary incontinence	1
Urinary retention	1
Verbal function	1
Speech and/or language	3
Violence	1
Total	**266**

IADLs = activities of daily living.

substance use). Health Promotion as a Judgment was unique to diagnostic concepts from the Omaha System.

Discussion and Conclusion

Reference terminology models such as the ISO Reference Terminology Model for Nursing Diagnoses are necessary for defining associative relationships between semantic categories of concepts to formally define molecular expressions for integration into concept-oriented terminologies such as the MED. Similar to another study that evaluated the utility of the model for integrating nursing diagnostic concepts into SNOMED CT,[29] we found the ISO model was useful for dissecting nursing diagnostic concepts for subsequent integration into the MED. The model and its related definitions facilitated the consistency of the dissections by the two coders. The model also served as a framework for generating appropriate hierarchies in the MED for definition and classification of nursing diagnostic terms. Prior to dissecting the nursing diagnoses, we made several pragmatic decisions designed to ease the effort of integrating the concepts into the MED, most notably

Table 2 ■ Judgment Hierarchy

Judgment Hierarchy	Frequency
Actual	39
Alteration	44
Compromised	1
Conflict	2
Deficit	20
Disabled	1
Distress	2
Disturbance	5
Dysfunction	2
Excess	2
Impairment	45
Incision	1
Intolerance	1
Noncompliance	7
Health promotion	40
Potential	4
Deficit risk	2
Excess risk	2
Impairment risk	1
Intolerance risk	1
Potential deficit	4
Potential distress	1
Potential impairment	31
Risk	8
Total	266

precoordination of Judgment and Potentiality. A second pragmatic decision was not to separately define Dimension. The ISO model provided a basis for discussions and decisions. Our decisions are not reflective of inadequacies in the model; rather, they reflect a pragmatic decision to precoordinate concepts in a manner that made sense within the context of the MED.

The model, while useful, is not sufficient for fully specifying nursing diagnostic concepts; hierarchical structures for descriptors that instantiate the semantic categories also are needed. For nursing diagnostic concepts, NANDA Taxonomy II and ICNP are sources of such hierarchical structures.[4,28] We chose to derive the structures from the two source terminologies that we planned to integrate and then to use the other sources to refine our hierarchies because, in some instances, NANDA and ICNP provided quite different organizations of Focus concepts. For example, in NANDA, "anxiety," "fear," and "sorrow (grief)" are categorized into the "coping responses" class in the coping/stress domain. In the ICNP, these are assigned to "emotion" under "self-awareness."

Limitations of our study include the fact that we included only two source terminologies and only one reference terminology. However, a requirement of reference models such as the ISO model is fidelity to representations of domain knowledge, and our analysis provided a test of this requirement.[7] Although the MED is used only in a single health care enterprise, it meets the terminology requirements espoused in the Desiderata[30]; thus, our findings might be useful to others seeking to incorporate nurs-

ing diagnoses into another concept-oriented terminology. Another limitation of the study relates to the fact that only two coders participated in the dissections. A larger number of coders would likely increase the variability.

Nursing care represents a large proportion of health care activities; thus, it is vital that terms used by nurses are integrated into concept-oriented terminologies that provide broad coverage for the domain of health care. The ISO Reference Terminology Model for Nursing Diagnosis provides a structure to begin this process; however, further testing is needed to refine the model. In particular, additional studies are needed to test the utility of the model to integrate nursing terms into larger concept-oriented terminologies and the subsequent impact of this integration on data aggregation and reuse, information retrieval, and decision support.

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