Research Paper ■

Terms Used by Nurses to Describe Patient Problems:

Can SNOMED III Represent Nursing Concepts in the Patient Record?

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Abstract **Objective:** To analyze the terms used by nurses in a variety of data sources and to test the feasibility of using SNOMED III to represent nursing terms.

Design: Prospective research design with manual matching of terms to the SNOMED III vocabulary.

Measurements: The terms used by nurses to describe patient problems during 485 episodes of care for 201 patients hospitalized for *Pneumocystis carinii* pneumonia were identified. Problems from four data sources (nurse interview, intershift report, nursing care plan, and nurse progress note/flowsheet) were classified based on the substantive area of the problem and on the terminology used to describe the problem. A test subset of the 25 most frequently used terms from the two written data sources (nursing care plan and nurse progress note/flowsheet) were manually matched to SNOMED III terms to test the feasibility of using that existing vocabulary to represent nursing terms.

Results: Nurses most frequently described patient problems as signs/symptoms in the verbal nurse interview and intershift report. In the written data sources, problems were recorded as North American Nursing Diagnosis Association (NANDA) terms and signs/symptoms with similar frequencies. Of the nursing terms in the test subset, 69% were represented using one or more SNOMED III terms.

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The need for a standardized health care vocabulary has been identified from several perspectives. From the perspective of nursing, Clark and Lang maintain that "if we cannot name it, we cannot control it, finance it, teach it, research it, or put it into public policy."[1] The Institute of Medicine report on the computer-based patient record[2] also described the standardization of health care vocabularies as a prerequisite for the patient record of the future and recommended a collaborative effort towards establishing a composite clinical data dictionary. Information system developers, health care organizations, and government agencies have developed proprietary clinical data dictionaries. However, as the legitimate demands for data for internal quality management and external reporting increase, standardized vocabularies are required for communication among distributed information systems and among institutions[3] and to facilitate clinical and outcomes research.[1,4]

This paper has three purposes. First, the efforts in nursing and in the larger health care arena to develop classification schemes or standardized vocabularies that describe patient problems, health care interventions, and patient outcomes are reviewed. Second, the terms used by nurses to describe the patient problems of 201 persons living with AIDS (PLWAs) hospitalized for *Pneumocystis carinii* pneumonia from four data sources—structured interview, inter-

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Table 1 ■

Comparison of Standardized Health Care Classification Schemes

Classification Scheme	Major Focus	Number of Terms	Data Elements		
			Problems	Interventions	Outcomes
NANDA Taxonomy	Nursing diagnoses	104 diagnoses	Nursing diagnoses		
Nursing Interventions Classification (NIC)	Nursing interventions	6 domains; 26 classes; 357 interventions		Nursing interventions	
Home Health Care Classification System	Home health care	147 diagnoses; 166 interventions; 20 home health care components	Nursing diagnoses	Nursing interventions	Discharge status
Nursing Intervention Lexicon and Taxonomy	Community health	10 categories of nursing interventions		Nursing interventions	
Omaha Community Health System	Community health	40 client problems; 4 intervention categories and 62 targets of interventions; 3 outcome measures	Client problems	Nursing interventions	Knowledge, behavior, patient status
Outcome Classification	Patient outcomes related to nursing care	14 categories of patient outcomes			Physiologic, psychological, functional status, behavior, knowledge, symptom control, home maintenance, well-being, safety, goal attainment, patient satisfaction, frequency of service, readmission, resolution of nursing diagnosis
ICD9-CM	Morbidity data for indexing medical records	18,307 preferred terms; 15,847 abbreviations; 130,071 index terms; 180 hierarchical titles*	Diseases, factors influencing health status, external causes of injury	Diagnostic and therapeutic procedures	

DSM-III-R	Mental disorders	267 preferred terms; 100 hierarchical titles*	Clinical syndromes, personality and developmental disorders, physical condition, psychosocial stressors, psychological functioning		
SNOMED III	Terms used in human and veterinary medicine	Topography, 12,385; morphology, 4,991; function, 16,352; living organisms, 24,265; chemicals, drugs, and biological products, 14,075; physical agents, forces, and activities, 1,355; occupations, 1,886; social context, 433; diseases/diagnoses, 28,622; procedures, 25,000 (estimated); general linkage-modifiers, 1,176	Signs and symptoms; medical diagnoses; nursing diagnoses, changes found in cells, tissues, and organs; bacteria and viruses; occupations, devices, and activities associated with disease	Administrative, diagnostic, and therapeutic procedures; drugs; nursing interventions	Discharge disposition
MeSH	Information retrieval	16,564 main concepts; 31,865 entry terms; 1,863 definitional synonyms; 15 hierarchical titles*	Biomedical concepts including diseases, body systems, organisms	Diagnostic and therapeutic procedures	
Physician's Current Procedural Terminology (CPT)	Procedures performed by physicians	7,299 preferred terms; 8,944 abbreviations or expanded abbreviations; 771 hierarchical titles*		Diagnostic and therapeutic procedures or services	
International Classification of Clinical Services	Laboratory, pharmacy	Approximately 30,000		Laboratory tests, medications	

*The types and numbers of terms are taken from Sheretz DD, Olson NE, Tuttle MS, Erlbaum MS. Source inversion and matching in the UMLS Metathesaurus. In: Miller RA, ed. Proceedings of the Fourteenth Annual Symposium on Computer Application in Medical Care. IEEE Computer Society Press, 1990:141–5.[34]

shift report, nursing care plan, and nurse progress note/flowsheet—are analyzed. Last, the feasibility of using SNOMED III to represent nursing terms for the description of patient problems in the nursing care plan and nurse progress note/flowsheet is examined.

Overview of Health Care Classification Schemes

As shown in Table 1, health care classification schemes vary in purpose, in scope, in structure, and in level of granularity of the data elements. Nursing classification schemes are a subset of the larger health care classification effort. However, because nursing terms are the focus of this paper, the nursing classification schemes are examined separately, followed by other single-purpose and multi-purpose health care classification schemes. In Table 2 the evaluation studies addressing the adequacy of existing classification schemes to represent clinical data in the patient record are summarized.

Nursing Classification Schemes

Although the need for a standardized vocabulary has been emphasized by the development of information systems and increased requirements for sharing of clinical data, classification schemes or taxonomies have been of interest to nursing since Nightingale's six nursing canons were published in the nineteenth century. These were followed by the development of Henderson's 14 categories of nursing care and Abdellah's 21 problems associated with health patterns of patients.[5] Since the late 1970s, the North American Nursing Diagnosis Association (NANDA) Taxonomy I has been the predominant, although not universal, classification system in nursing.[5,6]

NANDA Taxonomy I is a classification of nursing diagnoses by human response patterns.[6] Impaired skin integrity, activity intolerance, knowledge deficit, and anxiety are examples of nursing diagnoses. Related factors and defining characteristics are included for each diagnosis. Criticisms have focused on weaknesses in the internal consistency and theoretical underpinnings of the diagnoses.[7] This classification system continues to be refined by the ongoing research and development efforts of NANDA. For the purposes of this paper, the term NANDA diagnosis rather than the more generic phrase of nursing diagnosis is used to refer to the nursing diagnoses in the NANDA taxonomy.

Although the interest in the development of a standardized nursing vocabulary has been great, several authors have identified barriers to the development of the universe of relevant nursing data, including: the whole-person perspective of nursing; the multiplicity of the conceptual frameworks guiding nursing practice; the difficulties inherent in identification of the data elements in a nursing minimum data set, differentiation between nursing diagnoses and other problems of interest to nursing, and defining the data elements required to capture different nursing diagnostic or classification systems, interventions, and outcomes; and lack of a uniform coding format for nursing diagnoses.[1,7–12]

The development of classification schemes is the focus of several recently completed or ongoing nursing informatics research projects.[13–26] The design and implementation of a Nursing Minimum Data Set, led by Werley and colleagues, has provided impetus for research on standardized vocabularies for nursing.[13] The unique items related to nursing in the 16-item Nursing Minimum Data Set are nursing diagnosis, nursing intervention, nursing outcome, intensity of nursing care, and the identification number of the principal registered nurse provider.

The Nursing Interventions Classification (NIC),[14–16] also known as the Iowa Intervention Project, is a categorization of direct care activities performed by nurses. Each intervention consists of a label describing the concept, the definition of the concept, and a set of defining activities or actions. For example, Airway Management is defined as facilitation of patency of air passages. Associated activities include 1) Instruct how to cough effectively and 2) Monitor respiratory and oxygenation status as appropriate. The three-tiered taxonomy contains six domains (physiologic–basic, physiologic–complex, behavioral, family, health system, and safety), 26 classes, and 357 interventions.[16]

The Home Health Care Classification System[17,18] includes 20 home health care components, 147 nursing diagnoses, four classes of nursing interventions (assess, care, teach, and manage) comprising 166 nursing interventions, and discharge status (improved, stabilized, or deteriorated). Examples of home health care components are activity, self-care, health behavior, and metabolic.

The Nursing Intervention Lexicon and Taxonomy study[19–21] uses natural-language processing and an expert algorithm (Id3) to categorize nursing interventions generated by master's degree–prepared registered nurses completing a Hypercard instrument that included 12 case studies of community health clients. Ten categories of nursing interventions were identified: care environment management, care need

Table 2 ■

Evaluation Studies Related to the Use of Standardized Health Care Classification Schemes to Represent Clinical Data

Reference*	Study Purpose	Method	Results
Bouhaddou et al. (1993)[44]	To determine the number of concepts in the *Iliad* diagnostic expert system that were represented in *Meta 1.1*	Semi-automated lexical matching of main concepts	44% of main Iliad concepts were in Meta 1.1
Campbell and Musen (1992)[45]	To evaluate the feasibility of representing clinical data using *SNOMED III*	Descriptive	SNOMED III lacks a formalized system for using its codes; conceptual–graph formalisms can ensure consistency of use and mapping of SNOMED III codes onto representational data models and other formal systems
Campbell (1992)[46]	To evaluate the clinical utility of *Meta 1.1* to describe the process of care in ambulatory care of hypertension based on 2,500 SOAP notes from *COSTAR system*	SOAP note terms matched into UMLS semantic types; machine-assisted, manual review of clinical concepts	Matches for clinical concepts—subjective, 68%; objective, 20%; assessment, 75%; plan, 64%; overall, 58%
Chute et al. (1992)[47]	To evaluate the capacity of *Meta 1, ICD-CM,* and *SNOMED II* to characterize 675 natural-language surgical diagnoses	Semi-automated lexical matching for concepts; matches categorized as complete, broad, very broad, narrow, very narrow, related, distantly related, and poor match	Complete (exact) matches—Meta 1, 52%; ICD9-CM, 58%; SNOMED II, 61%
Cimino (1991)[48]	To compare *Meta 1* concepts with clinical laboratory terminology in use at the *Columbia–Presbyterian Medical Center* (CPMC)	CPMC terms matched to most specific Meta 1 semantic type	Exact matches—30%; partial matches—42%
Huff and Warner (1990)[4]	To compare *Meta 1* and *HELP* terms	Word by word matching and phrase by phrase matching	54% HELP words and 8% of HELP phrases in Meta 1
Li et al. (1992)[49]	To compare *Chinese Medical Nomenclature* (CMN) with *ICD10* and *SNOMED III*	Descriptive	CMN well correlated with ICD10 and SNOMED III
Zielstorf et al. (1992)[50]	To test if the terms for patient problems from *NANDA* and the terms for patient problems and nursing interventions from the *Omaha Community Health System* were present in *Meta 1*	Automated scanning for lexical matches for intact words or phrases and for core concepts	Exact matches—9% of NANDA terms, 1% Omaha problems, 34% Omaha interventions; partial matches—56% NANDA terms, 80% Omaha problems, 36% Omaha interventions

*See the reference list for complete information.

determination, care information provision, care vigilance, care vigilance–specific, therapeutic care–general, therapeutic care–alternatives; therapeutic care–cognitive understanding and control, therapeutic care–psychosocial, and therapeutic care–specific.

The Omaha Community Health System[22,23] consists of standardized schemes of nursing diagnoses, interventions, and ratings of outcomes for patient problems. The problem-classification scheme includes 40 client problems or nursing diagnoses, two sets of modifiers, and clusters of signs/symptoms. The in-

tervention scheme is a taxonomy of four intervention categories and 62 targets or objects of the nursing interventions. In the outcomes scheme, client progress in relation to specific problems is rated on the dimensions of knowledge, behavior, and status.

Outcome classifications have been studied less frequently than classification schemes for problems and interventions. Lang and Marek[24–26] proposed the following categories of outcomes related to nursing care: physiologic, psychological, functional status, behavior, knowledge, symptom control, home maintenance, well-being, goal attainment, patient satisfaction, safety, frequency of service, readmission, and resolution of nursing diagnosis or problem. Quality of life has also been proposed as an outcome related to nursing care.[27]

General Classification Schemes

Standardized health care vocabularies that describe patient problems include the International Classification of Diseases—Clinical Modification (ICD9-CM),[28] the Diagnostic and Statistical Manual of Mental Disorders (DSM-III-R),[29] Systematized Nomenclature of Medicine (SNOMED III),[30] and Medical Subject Headings (MeSH).[31] Classification schemes for interventions include the Physician's Current Procedural Terminology[32] and the International Classification of Clinical Services,[33] as well as procedures listed in ICD9-CM[28] and SNOMED III.[30]

ICD9-CM[28] was designed to provide basic health care statistics and to classify morbidity data for the indexing of medical records, medical case reviews, and other health care programs. Categories of ICD9-CM codes include diseases, factors influencing health status and contact with health services, and external causes of injury and poison. ICD9-CM also classifies diagnostic and therapeutic procedures by organ system—for instance, operations of the cardiovascular system. ICD9-CM codes are required data elements in the Health Care Financing Agency's Uniform Clinical Data Set (UCDS)[34] and in the Uniform Hospital Discharge Data Set (UHDDS).[35] Additionally, the codes are used for hospital billing purposes.

The purpose of DSM-III-R is to classify mental disorders.[29] Disorders are classified along five axes: clinical syndromes, personality disorders and special developmental disorders, relevant physical conditions, severity of psychosocial stressors, and overall psychological functioning. The domain is limited to mental disorders and the classification is not completely hierarchical.[36] A strength of DSM-III-R is the plethora of research examining the reliability and validity of the classification.

SNOMED III[30] classifies patient findings into 11 modules: 1) *topography*—anatomic terms, 2) *morphology*—changes found in cells, tissues, and organs, 3) *living organisms*—bacteria and viruses, 4) *chemical*—drugs, 5) *function*—signs and symptoms, 6) *occupation*—terms to describe occupations; 7) *diagnosis*—diagnostic terms used in clinical medicine; 8) *procedure*—administrative, therapeutic, and diagnostic procedures; 9) *physical agents, forces, and activities*—devices and activities commonly associated with disease; 10) *social context*—social conditions and relationships of importance in medicine; and 11) *general*—syntactic linkages and qualifiers. NANDA diagnoses are included in SNOMED III in the function module and nursing procedures are included in the procedure module.

Medical Subject Headings (MeSH) was designed for information retrieval purposes.[31] Terms in the classification are primarily hierarchical. MeSH has broader biomedical subject coverage and more extensive contextual information for each of its terms than other standardized vocabularies such as ICD9-CM or SNOMED III.

Physicians' Current Procedural Terminology (CPT)[32] is a systematic listing and coding of procedures performed by physicians. The procedures and services are grouped into five categories: medicine, anesthesiology, surgery, radiology (including nuclear medicine and diagnostic ultrasonography), and pathology and laboratory. There are open codes for unlisted procedures or services. Specific modifiers are included in CPT, such as, only part of a service was performed or a service or procedure was performed by more than one physician. Currently CPT codes are used primarily for billing purposes.

The International Classification of Clinical Services (ICCS)[33] was designed to organize hospital billing data so that they are more accessible and useful for clinical and financial applications. Although the domain is limited, the 12-digit codes allow a specificity beyond what is found in ICD9-CM or SNOMED III. For example, Kanamycin is a descendant of Drug, Anti-Infectives, and Aminoglycosides, and an ancestor of Oral, Capsules, 500, and MG. This specificity resulted in over 7,000 codes for drugs alone.

The current emphasis on outcomes has been fueled by federal[26] and state legislation,[35] health care accreditation organizations, the consumer movement, and third-party payers. Traditional outcome measures such as mortality, length of stay, cost, and hospital readmissions[3] and a focus on "what went wrong" (e.g., nosocomial infection rate and patient falls) have been supplemented by additional patient outcome

measures such as quality of life and patient satisfaction. However, these outcomes are frequently not available in the patient record.

There is no comprehensive classification scheme for health care outcomes. However, several data sets contain elements related to outcomes. The Uniform Clinical Data Set (UCDS)[34] is a set of 1,600 data elements collected for the purpose of quality screening by Peer Review Organizations. Data elements related to Health Care Financing Agency (HCFA) generic quality screens and discharge status and disposition are organized into Quality of Care algorithms. These include the following areas: adequacy of discharge planning, medical stability at discharge, deaths, infections, unscheduled return to surgery, and iatrogenic events.

The Uniform Hospital Discharge Data Set is a set of data elements related to client demographics and hospital services.[35] It includes data elements that are indicative of patient outcomes, for example, disposition of the patient, costs, and length of stay. Additionally, ICD9-CM codes appearing as secondary diagnoses may include diagnoses that represent outcomes that are complications of treatment.[28]

The existing data elements in standardized vocabularies provide only a limited view of patient outcomes. Important outcome indicators such as patient satisfaction and health status are not well represented. The Institute of Medicine report on the computer-based patient record[2] identified patient health status as the single most important data element that is usually missing in the patient record. Fries has proposed a chronic disease data-bank model that includes patient status and quality-of-life measures in addition to traditional outcomes measures.[37] There are ongoing efforts towards the development, refinement, and validation of health status measures such as the SF-36[38] and the Quality Audit Marker[27] and patient satisfaction measures such as the Risser Patient Satisfaction Scale.[39]

Unifying Efforts

The National Library of Medicine has funded a project entitled the Unified Medical Language System (UMLS).[31] The aim of the project is to establish a conceptual link between the user's information need and information sources, including biomedical literature, clinical records, databases, knowledge bases, and directories of information resources. The central vocabulary tool of the UMLS is Meta 1, or the Metathesaurus. The base vocabulary in the Metathesaurus includes portions of many of the standardized vocabularies discussed in this paper (NANDA, Nursing Intervention Classification, ICD9-CM, DSM-III-R, SNOMED II, CPT, and MeSH). Additionally, a set of terms used in three COSTAR[40] ambulatory care sites, and selected laboratory procedures are included. Plans are in place to add the classification schemes of the Home Care Classification System[17] and the Omaha Community Health System[22] to the UMLS. Concurrent work on the UMLS Semantic Network is focused on defining the relationships among the terms.

Other efforts include the work of the American National Standards Institute (ANSI) Healthcare Informatics Standards Planning Panel (HISPP) in coordinating the work groups for health care data interchange and health care informatics (e.g., ACR/NEMA, ASTM, HL7, IEEE), with the goal of achieving the evolution of a unified set of nonredundant, nonconflicting standards.[41] In another project, the CANON Group[42] is attempting to develop standards for medical concept representation of the types of clinical data commonly found in handwritten and dictated clinical notes. The International Council of Nursing in pursuing the establishment of an international family of taxonomies of problems, interventions, and outcomes within the framework of a Unified Nursing Language System.[1]

Evaluation Studies

Only a few studies were located that evaluated the adequacy of standardized classification schemes to represent clinical data.[4,43–50] The purposes, methods, and results of these studies are presented in Table 2. The majority of the evaluation studies focused on comparisons between UMLS Metathesaurus terms and schema from existing clinical systems such as the Iliad diagnostic expert system,[44] HELP,[4] COSTAR,[46] and the laboratory terminology from Columbia–Presbyterian Medical Center[48] or with other classification schemes such as ICD9-CM,[47] SNOMED II,[47] and the Index for Radiological Diagnoses.[49] Only one study was found that evaluated the adequacy of Metathesaurus terms to represent nursing concepts: Zielstorf et al.[50] found exact matches for only 9% of the NANDA terms, 1% of the Omaha system problems, and 34% of the Omaha system interventions. The evaluation studies were unanimous in their conclusions that while each vocabulary served the purpose for which it was designed, no one existing vocabulary or unifying scheme was adequate to represent the broad array of clinical data in the patient record.

Additional experiments are needed to describe the nomenclature or terms used by health care providers to describe patient problems, health care interventions, and patient outcomes. The existing vocabularies need to be tested and refined in order to provide

the language for the computer-based patient record of the future and to facilitate clinical and outcomes research.

Study Purpose

The purpose of this study was to analyze the terms used by nurses to describe patient problems in a variety of data sources and to test the feasibility of using an existing vocabulary, SNOMED III, to represent the nursing terms. SNOMED III was chosen for evaluation for four reasons. Preliminary findings[51,52] suggested that nurses frequently describe patient problems in terms of signs, symptoms, and medical diagnoses as well as NANDA diagnoses, and SNOMED III includes representation for each of those categories of terms. Second, the relational modifier "due to" which is used to specify NANDA diagnoses is included as a code in the general linkage-modifier module of SNOMED III and the medical diagnoses and drugs that frequently follow the "due to" in a NANDA diagnosis statement can be comprehensively represented with the terms in the diagnosis and chemical modules of SNOMED III. Third, Campbell and Musen,[45,53] as part of ongoing research to develop a computer-based medical-progress–note generator, found SNOMED III sufficiently expressive to represent clinical data because of its domain completeness and generative coding scheme that allows the construction of codes that contain modifiers and time references. Last, no study was located that tested the feasibility of using SNOMED III to represent nursing concepts in the patient record.

Methods

Questions

Two research questions were addressed in this study:

1. What are the frequencies of the types of terms (NANDA diagnosis, medical diagnosis, sign/symptom, patient goal, or other) used by nurses to describe patient problems during a nurse interview, in the intershift report, in the nursing care plan, and in the nurse progress note/flowsheet?

2. Can the terms used by nurses to record patient problems in the nursing care plan and in the nurse progress note/flowsheet be represented with SNOMED III terms?

Design

This study is part of a larger research project, "Quality of Nursing Care of Persons with AIDS" (NR02215, William L. Holzemer, principal investigator), designed to examine the linkages among patient problems, nursing interventions, and patient outcomes over time. For this experiment, a descriptive, prospective design was utilized to examine the terms used by nurses to describe patient problems.

Sample

The data for this study represent a total of 485 patient encounters for 201 patients living with AIDS (PLWAs) who were hospitalized for *Pneumocystis carinii* pneumonia. Data were collected at three points in time during the hospitalization: near admission, approximately midpoint, and near discharge. Some patients were not seen at three points in time because their lengths of stay were too short. The study settings included a tertiary care university medical center, a university-affiliated public hospital, and a community hospital. The three settings for the study had three different types of care planning systems and three types of nurses' progress notes. In the first institution, the care plans were computer-based and the nurses' progress notes were written in narrative style. In the second institution, the care plans were handwritten and the progress notes were written on a flowsheet using charting by exception. A standardized printed care plan with a flowsheet and once-daily narrative note were used in the third institution.

Procedure

The patient problems were obtained from four data sources. The nurse caring for the patient was asked to identify the patient's three or four major problems during a short interview. The patient problems were manually recorded by a research assistant during intershift report. The patient charts were audited to identify the patient problems recorded in the nursing care plan and in the nurse progress note/flowsheet. The nursing terms were entered into a relational database (Paradox) and classified on two dimensions. Based on the substantive nature of the problem, the patient problems were classified into an empirically generated six-category scheme[52]: PCP-related problems (e.g., shortness of breath); acute and chronic problems related to AIDS (e.g., diarrhea); problems related to psychosocial concerns (e.g., anxiety); problems related to lack of knowledge (e.g., knowledge deficit related to routes of HIV transmission); problems related to hospitalization; and other problems. According to the semantics of the terms used, each term was classified into one of five mutually exclusive categories: NANDA diagnosis; medical diagnosis; sign/symptom; patient goal; or other. Terms such as

Table 3 ■

Frequencies of Nursing Terms by Data Source, Substantive Category, and Type of Terminology Used to Describe the Patient Problem

Data Source/Problem	MD Diagnosis	NANDA	Sign/Symptom	Goal	Other	Total
Nurse interview						
PCP-related	59	40	473	21	115	708
Acute and chronic AIDS	47	64	76	4	22	213
Psychosocial	3	78	108	3	123	315
Lack of knowledge	0	2	0	1	23	26
Total	**109**	**184**	**657**	**29**	**283**	**1,262**
Intershift report						
PCP-related	90	42	556	15	73	776
Acute and chronic AIDS	52	60	96	2	13	223
Psychosocial	1	47	45	0	59	152
Lack of knowledge	0	0	0	1	7	8
Total	**143**	**149**	**697**	**18**	**152**	**1,159**
Nursing care plan						
PCP-related	3	200	243	37	57	540
Acute and chronic AIDS	1	164	44	5	23	237
Psychosocial	0	16	103	2	100	221
Lack of knowledge	0	13	2	15	106	136
Total	**4**	**393**	**392**	**59**	**286**	**1,134**
Nurse progress note						
PCP-related	0	114	153	20	80	367
Acute and chronic AIDS	33	83	40	0	41	197
Psychosocial	0	34	19	0	27	80
Lack of knowledge	0	0	2	2	59	63
Total	**33**	**231**	**214**	**22**	**207**	**707**
TOTAL	**289**	**957**	**1,960**	**128**	**928**	**4,262**

pain and diarrhea that are both a symptom and a NANDA diagnosis were categorized as NANDA diagnoses.

In order to test how well the SNOMED III terms represent the written nursing terms in the nursing care plan and in the nurse progress note/flowsheet, the SNOMED III terms were loaded into a relational database and a word index was created. The authors determined matches by identifying the description of the SNOMED III term or terms that best matched each term charted by the nurses.

Results

The frequencies of nursing terms by data source, category of problem, and terminology used are shown in Table 3. This analysis is limited to problems identified in the first four of the six substantive categories because the problems identified in the categories of issues related to hospitalization and other were generally not clinical in nature. A total of 4,262 problems were recorded: 1,262 problems from the nurse interview; 1,159 problems from the intershift report; 1,134 problems from the nursing care plan; and 707 problems from the nurse progress note/flowsheet. Consistent with the patients' principal diagnosis, the most frequently occurring category of problems in all data sources was PCP-related problems, representing 56% of the problems reported. Of note, however, is the fact that 44% of the problems reported fell into the three categories: acute and chronic AIDS-related problems, problems related to psychosocial concerns, and problems related to lack of knowledge.

In the verbal sources of data (nurse interview and intershift report), the type of term used most frequently to describe the patient problems was signs/symptoms. NANDA diagnoses were used to describe only 15% of the problems in the nurse interview and 13% of the problems in the intershift report. NANDA diagnoses were used more frequently in the written data sources (nursing care plan and nurse progress note/flowsheet) than in the verbal data

Table 4 ■

Representation of a Test Subset of Terms Used by Nurses in the Nursing Care Plan and Nurses' Progress Notes/Flowsheet with SNOMED III Terms

Term Charted by Nurse	Frequency	Term Type	SNOMED III Terms
Problems related to respiratory function			
Impaired gas exchange	109	NANDA diagnosis	F-0A930
Respiratory distress including shortness of breath (SOB), dyspnea on exertion (DOE), tachypnea, cough, cyanosis	99	Sign/symptom & other	SOB = F-20040; DOE = F-20050; tachypnea = F-21003; cough = F-24100; cyanosis = M-04100 (morphology change)
Diminished breath sounds	10	Sign/symptom	Breath sounds = F-23002, diminished = G-A316 (modifier)
Crackling rales	13	Sign/symptom	F-23410
Oxygen saturation = [value]	6	Sign/symptom	No direct match; potential match for decreased saturation is hypoxia = F-60294 (symptom)
Problems related to body temperature			
Potential for hyperthermia	55	NANDA diagnosis	F-0A420
Hyperthermia	3	NANDA diagnosis	F-0A440
Fever	114	Sign/symptom	F=03003
Temperature = [value]	16	Sign/symptom	No direct match; potential matches for high value are fever = F-03003 (symptom) or hyperthermia = F-0A440 (NANDA diagnosis)
Problems related to activity			
Activity intolerance (specify)	40	NANDA diagnosis	F-0A810
Fatigue/malaise	47	Sign/symptom	F-01360
Weakness	3	Sign/symptom	F-01380
Unsteady/weak gait	8	Sign/symptom	F-18003
Potential for injury	25	NANDA diagnosis	F-0A160
Problems related to elimination			
Alteration in bladder/bowel elimination	21	Other	No direct match; potential matches are elimination = F-60950 if NOS; alterations in patterns of urinary elimination = F-0A690 (NANDA diagnosis); diarrhea = F-0A610 (NANDA diagnosis) or F-54400 (symptom)
Constipation	2	NANDA diagnosis	F-0A600
Diarrhea	2	Sign/symptom & NANDA diagnosis	F-54400 (symptom) or F-0A610 (NANDA diagnosis)
Elimination of body wastes (specify)	33	Other	No direct match; potential matches are elimination = F-60950; alteration in patterns of urinary elimination = F-0A690 (NANDA diagnosis; diarrhea = F-0A610 (NANDA diagnosis) or F-54400 (symptom)
Problems related to nutrition status			
Alteration in fluid/nutrition status	45	NANDA diagnosis	F-0A320 (nutrition); F-0A360 (fluid)
Anorexia; nausea/vomiting; diarrhea; dehydration	31	NANDA diagnosis, sign/symptom, medical diagnosis	Anorexia = F-50015 (symptom); nausea = F52760 (symptom); diarrhea = F-0A610 (NANDA diagnosis) or F-54400 (symptom); dehydration = D6-20650 (medical diagnosis)
Problems related to psychosocial concerns			
Anxiety, anger, depression, and/or fear	55	NANDA diagnosis, sign/symptom	Anxiety = F-0B320 (NANDA diagnosis) or F-92238 (symptom); depression = F-

continued

Term Charted by Nurse	Frequency	Term Type	SNOMED III Terms
			92300 (symptom); fear = F-0B300 (NANDA diagnosis) or F-92246 (symptom)
Disturbance of emotional well-being	45	Other	No direct match; potential matches are ineffective coping = F-0B800 (NANDA diagnosis) or specific symptoms such as fear, anxiety
Problems related to lack of knowledge			
Knowledge deficit related to (specify)	10	NANDA diagnosis	F-0B170
Need for teaching (specify who) related to (specify)	113	Other	No direct match; potential match is knowledge deficit = F-0B170 (NANDA diagnosis)
Teaching related to (specify)	64	Other	No direct match; potential match is knowledge deficit = F-0B170 (NANDA diagnosis)

sources. NANDA diagnoses and signs/symptoms were each used to describe 35% of the problems in the nursing care plan. In the nurse progress note/flowsheet, NANDA diagnoses were used to describe 33% of the problems and signs/symptoms to describe 30% of the problems. Medical diagnoses were used infrequently in the written data sources.

For the analyses related to testing the ability of SNOMED III to represent the terms used by nurses to describe patient problems, only the written data sources (nursing care plan and nurse progress note/flowsheet) were used because of the investigators' belief that standardized vocabularies are designed to capture the more formal language of the written record versus the informal semantics of verbal communication. A total of 1,841 patient problems, comprised of 761 unique terms, were recorded from the nursing care plan and the nurse progress note/flowsheet. The number of unique terms was limited by the structured care-planning systems in two institutions (computer-based and standardized), the use of flowsheets (two institutions), and charting by exception in the nurse progress note (one institution).

To test the feasibility of using SNOMED III terms to represent nursing data, a test subset of the most frequently occurring problems identified across data sources and substantive categories was selected, resulting in seven problem areas (respiratory function, body temperature, activity, nutrition status, elimination, psychosocial concerns, and lack of knowledge) represented by 25 nursing terms. The 25 terms represented a total of 969 patient problems, or 53% of the problems from the nursing care plan and the nurse progress note/flowsheet. These terms are also reflective of common problems in other patient populations.

The terms used by the nurses to describe patient problems in the nursing care plan and in the nurse progress note/flowsheet, the frequencies of the terms, term types (NANDA diagnosis, medical diagnosis, sign/symptom, patient goal, or other), and the matching SNOMED III term/terms or the potential SNOMED III terms are presented in Table 4. The letter in the SNOMED III term relates to the module in which the term is located. The majority of the terms in this analysis were represented with terms from the function module, and the codes begin with the letter F. A few nursing terms (e.g., cyanosis, dehydration) were represented by terms from the morphology (M) or diagnosis (D) module. If more than one SNOMED III term was located, the multiple terms are listed and each term is labeled. If no direct match was found for the terms recorded by the nurses, alternative matches were proposed by the authors.

The patient problems described as NANDA diagnoses were exact matches with the NANDA diagnosis terms in the function module of SNOMED III. They included impaired gas exchange, potential for hyperthermia, hyperthermia, activity intolerance, potential for injury, anxiety, fear, diarrhea, constipation, and knowledge deficit. The term alteration in fluid/nutrition status required two nursing diagnoses—alteration in nutrition status and alteration in fluid status—for a match.

Symptoms such as shortness of breath, tachypnea, fever, fatigue/malaise, nausea, vomiting, and depression were exact matches with terms in the function module of SNOMED III, as were signs such as crack-

Table 5 ■

Frequencies of SNOMED III Terms Matching a Test Subset of Terms Used by Nurses to Describe Patient Problems and Numbers of SNOMED III Terms Required for Match

Type of Term Charted by Nurse	Number of SNOMED III Terms Required for Match (Frequency of Terms Recorded)			
	1	2	>2	No Match
NANDA diagnosis	242	45	0	0
Sign/symptom	185	0	0	22
Other	0	0	0	276
Sign/symptom and NANDA	4	55	0	0
Sign/symptom and other	0	10	99	0
Sign/symptom, NANDA, and MD Dx	0	0	31	0
Total	**431**	**110**	**130**	**298**

ling rales and weak gait. Signs recorded as actual values, such as body temperature and percent oxygen saturation, did not have matching terms in SNOMED III.

Patient problems described as series of terms (e.g., anxiety, anger, depression, and/or fear) were represented by series of SNOMED III terms without difficulty. Dehydration was the only medical diagnosis in this analysis and was an exact match with an existing SNOMED III term.

There were redundant SNOMED III terms for fear and diarrhea. The nursing diagnosis terms added to SNOMED III duplicated an existing SNOMED term, resulting in two different codes for the same term.

The frequencies of matches of SNOMED III terms with the terms recorded by the nurses in the nursing care plan and nurse progress note/flowsheet and the numbers of SNOMED III terms required to represent the terms are presented in Table 5. Forty-four percent of the terms in the test subset were direct matches with one SNOMED III term. These were primarily NANDA diagnoses and single signs or symptoms. Two SNOMED III terms were required to represent 10% of the terms in the test subset. More than two SNOMED III terms were needed to match the terms in this test subset in 130 instances. Overall, 69% of the terms in the test subset were matched by using one or more SNOMED III terms.

Discussion

These findings suggest that nurses frequently use terms other than NANDA diagnoses to report patient problems both verbally and in the written record. Signs and symptoms were the most frequently used terms in the nurse interviews and intershift reports. Nursing diagnoses and signs or symptoms were used with similar frequencies in both the nursing care plan and the nurse progress note/flowsheet. Although medical diagnoses were used to describe patient problems in the nurse interview and in the intershift report, they were recorded infrequently by the nurses in the written record.

The addition of the NANDA Taxonomy I classification scheme to SNOMED III provided exact matches for the NANDA diagnoses in the data set in these analyses. However, NANDA terms alone were not sufficient to represent the broad variety of terms recorded by nurses in the nursing care plan and in the nurse progress note/flowsheet. Other SNOMED III terms were direct matches for the signs and symptoms recorded by the nurses to describe patient problems. Using NANDA terms alone provided matches for 30% of the patient problems described. The inclusion of other SNOMED III terms and combinations of SNOMED III terms increased the matches to 69%.

There were no SNOMED III matches for some terms recorded by the nurses. These were terms primarily classified as other because they were not recorded as NANDA diagnoses, medical diagnoses, signs/symptoms, or patient goals. There were three distinct reasons for the inability of SNOMED III to represent the terms recorded by the nurses. Some terms charted by the nurses, such as alteration in bowel/bladder elimination and disturbance of emotional well-being, were less specific than the SNOMED terms. In both of these instances, potential SNOMED III terms existed that conceptually matched the source terms upon further specification of those terms. This finding is consistent with that of Chute et al.[47] related to surgical diagnostic phrases. A second difficulty was in the area of problems related to lack of knowledge. Although there is a NANDA diagnosis for knowledge deficit, nurses more frequently used terms such as "need for teaching" or "teaching related to" than the NANDA diagnosis. These terms are conceptually equivalent to knowledge deficit and could potentially be coded as the NANDA diagnosis of knowledge deficit in SNOMED III. Last, SNOMED III has no mechanism for recording exact values such as temperature or oxygen saturation, which are most frequently recorded as actual values in information systems rather

than coded as another data type such as a medical diagnosis or a sign.

Refinement of the SNOMED III terms to remove duplicate terms for concepts such as diarrhea and fear or a method for determining equivalency of redundant statements is necessary. Campbell and Musen[45] proposed the application of conceptual-graph formalisms to SNOMED III as a strategy for enhancing construction of statements with complex relationships. The findings of this study demonstrate that the terms recorded by nurses can be complex and that such an enhancement would facilitate the representation of nursing terms as well as medical terms in the patient record.

The generalizability of the study findings must be considered in view of several limitations. The subjects for the patient problems were persons living with AIDS hospitalized for *Pneumocystis carinii* pneumonia, and although the breadth of problems described was great, the patient problems described for this sample of patients may differ from those of the general hospitalized patient population. The three settings represented three different types of nursing documentation systems; however, the findings may vary in other types of systems.

In conclusion, the study findings suggest that SNOMED III with the inclusion of NANDA diagnoses has the potential to represent more nursing concepts than do NANDA terms alone because of its broader domain. These findings also suggest that, in addition to continuing the effort towards inclusion of nursing classification systems into existing standardized health care vocabularies,[50] the nursing profession must test the feasibility of using existing vocabularies to represent nursing concepts.

Collaborative efforts towards the establishment of a standardized health care vocabulary that will support the needs of various applications and that can represent the terminology of the many disciplines providing health care must continue. Additional experiments are needed to test the abilities of existing vocabularies to meet the challenges posed by the computer-based patient record and to provide guidance for the refinement and enhancement of those vocabularies.

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