Information Model and Terminology Model Issues Related to Goals

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Goal statements are a significant component of structures that support the process of health care delivery such as practice guidelines, standards of care, critical pathways, disease management plans, patient education plans, and nursing care plans. Although these structures are increasingly computer-based, there has been little attention to the formal representation of goal statements. This is a necessary prerequisite for enabling semantic interoperability. Existing and evolving information model and terminology model standards offer some approaches that may be applicable to goal statements, however, a number of issues require resolution.

INTRODUCTION

Goal statements are a significant component of structures that support the process of health care delivery such as practice guidelines, standards of care, critical pathways, disease management plans, patient education plans, and nursing care plans. These structures are increasingly shifting from paper-based to computer-based formats. Significant efforts are underway to formally represent the knowledge and logical algorithms in guidelines and other types of structures that incorporate practice parameters. [1, 2]

The role of concept-oriented (i.e., formal) approaches in semantic interoperability [3, 4] is widely acknowledged and tremendous progress has been made toward formal representation of diagnostic (e.g., medical diagnoses, laboratory observations) [5] and therapeutic (e.g., surgical procedures, clinical drug, nursing interventions) concepts. [6-8] Some work has examined concept-oriented approaches to representing outcome measurements, [9] however, there has been little attention to the formal representation of goal statements.

In this paper we critically analyze the semantic structure of selected goal statements. Second, we explore alternate representation strategies using existing and evolving information model and terminology model standards. Third, we discuss outstanding issues and implications for the development of reference information models and reference terminologies that support the integration of goal statements into computer-based applications.

BACKGROUND

What is a goal? Common across the definitions in shown in Table 1 are the notions that a goal is a *target* or end towards which some type of *effort* is directed. Both the Health Level 7 (HL7) [10] and Patient Care Data Set (PCDS) [11] definitions of goal include the fact that the objective is achieved through healthcare intervention (broadly interpreted for this paper to include self-care interventions). Moreover, goals may be set for a variety of dimensions of a healthcare problem including condition, status, knowledge, and behavior.

Table 1. Definitions of Goals

The end toward which effort is directed [12]
An objective to be achieved as a consequence of healthcare interventions applied to an individual. Goals are set in many areas of the healthcare system, and include educational, behavior modification, and clinical goals such as reduced discomfort, improved circulation. Goals are documented by a variety of healthcare professionals including physicians, nurses, and respiratory and other therapists. Goals are defined during patient visits and they may span one or more multiple visits, encounters, or episodes of care. [10]
The patient condition or behavior deemed to be achievable with appropriate patient care. [11]

For an individual, a goal statement instance most often also contains a specific time frame, e.g., with a particular number of weeks or by a specific date by which the goal achievement is expected. For example:

- Diabetes well being questionnaire score 16 by week four of diabetic education.
- Lose twenty pounds by November 15, 2003.
- Demonstrate correct technique for insulin injection prior to hospital discharge.

How are goals different from and similar to outcomes? Our premise is that both goals and outcomes are types of findings and are necessarily related to healthcare interventions. The primary distinctions are two. First, goals specify *expected* or *desired* outcome (e.g., behavior, functional status, physiological value) rather than *actual* outcome and consequently serve as a benchmark against which the actual outcome is evaluated (goal variance measurement in HL7 parlance). This is in contrast to outcome evaluation that compares actual measurements prior to and after a healthcare intervention. Second, goals are set (i.e., expected

outcomes specified) in advance of the interventions used to achieve them. Although goals may be set based upon an actual finding (current knowledge of diabetes management is minimal and the goal is increase the knowledge to moderate), other goals are set based upon standards of care or practice guidelines without necessarily considering the patient's current status related to the goal (e.g., glycated hemoglobin <7 as a goal for all patients with diabetes mellitus). Nursing Outcomes Classification (NOC) developers note that outcomes are typically at a higher level of abstraction than goals. [13]

Table 2. Types of Findings

Observation	O_{1A}		O_{2A}
Outcome	O_{1A}	X	O_{2A}
Goal		X	O_E
Goal Variance		X	$O_E - O_{2A}$

O=observation; X=intervention; A=actual; E=expected

The nursing process explicitly incorporates the step of identification of expected outcomes prior to the selection of interventions. Consequently it is no surprise that goals and outcomes have received considerably more attention from nursing terminology developers than from the developers of more physician-oriented healthcare terminologies. Standardized nursing terminologies, with the exception of the PCDS which explicitly includes goals as well as patient care problems, have typically adopted a problem- or nursing diagnosis-based approach to looking at actual and/or expected outcomes. In this approach the current or expected future status of a problem or diagnosis is rated on some type of nominal, ordinal, or interval scale. For instance, in the International Classification of Nursing Practice (ICNP®), nursing outcomes are conceptualized as the "putative results of nursing interventions measured over time as changes effected in nursing diagnoses" (p.81). [14] The Omaha System measures selected problems on the dimensions of status, individual or family knowledge, and individual or family behavior pre- and post-intervention using a 5-point Likert-type scale. [15] In the Home Health Care Classification (HHCC), the expected outcome (improved, stabilized, deteriorated) is selected for each nursing diagnosis. The developer states that the same scale can be used to measure actual outcomes. [16]

Goals are an important part of the health care process. Several existing terminologies include terms that are potentially useful as descriptors for goal semantic structures, however, no formal representation for goal statements exists. Such a representation is a prerequisite for inclusion of goal statements in computer-based systems in a manner that enables semantic interoperability among heterogeneous systems.

METHODS

Research Questions

- What is the semantic structure of goal statements?
- How does the semantic structure of goal statements relate to existing and evolving information model and terminology model standards?

Sample

We selected the domain of diabetes management for analysis because of its clinical significance and multi-disciplinary management strategies. We obtained goal statements from two practice guidelines and three standardized terminologies. Guideline sources were the American Diabetes Association's Standard of Medical Care for Patients with Diabetes Mellitus, [17] and Management of Type 2 Diabetes Mellitus from the Institute for Clinical Systems Improvement [18]. Standardized terminologies were: HHCC, [19] NOC, [13] and PCDS. [11] We selected specific terminologies because they explicitly included patient goals or standardized terms that can be used to represent either actual or expected outcomes.

Analysis

First, we dissected the goal statements to identify semantic structures. Second, we compared the semantic structures of the goal statements to the semantic structures in two information models (HL7 2.4 and 3.0) [10, 20] and two terminology models (Clinical Logical Observation Names, Identifiers, and Codes [LOINC] [5] and International Standard Organization [ISO] Reference Terminology Model for Nursing Diagnoses). [21]

RESULTS

Goal Statement Dissections

The goal statements from the practice guidelines and selected standardized terminologies are shown in Table 3. Two distinct semantic patterns are seen in the statements. The goal statements from the two practice guidelines and from the PCDS represent a pre-coordinated semantic structure in that the statements include the name (label) of the goal and the desired value for the goal. In addition, the PCDS includes a set of ranked standardized terms related to the achievement status of a goal (1=Abandoned,, 2=Regressing, 3=Delayed, 4=Progressing on schedule, 5=Progressing ahead of schedule, 6=Achieved).

A second pattern of semantic structures is seen in NOC and HHCC. The name of a specific finding that is worded either in a neutral (Compliance Behavior)

or negative (Noncompliance of Dietary Regimen) fashion is designed for use in conjunction with a rating scale for that finding. The desired or expected value is not pre-specified; it is set at the time that the goal instance is created. In all but one statement in our sample of goals, the target for the goal was unambiguous; either explicitly or implicitly the patient. The exception is Knowledge: Diabetes management that could possibly relate to a patient or to a family caregiver.

Table 3. Goal Statements of Relevance to Diabetes Mellitus from Practice Guidelines and Selected Standardized Terminologies

Goal Statement	Desired Value	Possible Values
Practice Guidelines		
Average preprandial glucose (mg/dl) 80-120 [17]	80-120	
Glycated hemoglobin <7 [17]	<7	
Blood pressure <130/80 [17]	<130/80	
Low-density lipoprotein cholesterol # 100 mg/dl [17]	# 100 mg/dl	
Tobacco use [18]	No tobacco use	
Standardized Terminologies		
Patient will have appropriate glucose level. (GOL_09100.00) [20]	Appropriate	
Patient will remain free of signs or symptoms of blood glucose alteration. (GOL_09100.01) [20]	No signs or symptoms of glucose alteration	
Urine will test negative for glucose or ketones. (GOL_09100.02) [20]	Negative glucose, negative ketones	
Blood glucose control (2300) [13]		1=Not at all – 5=To a very great extent
Knowledge: Diabetes management (1820) [13]		1=None – 5=Extensive
Compliance Behavior (1601) [13]		1=Never demonstrated – 5=Consistently demonstrated
Endocrine Alteration (I22.0)[1][19]		Improved, Stabilized, Deteriorated
Noncompliance of Dietary Regimen (G20.2)[1][19]		Improved, Stabilized, Deteriorated

[1]=included in LOINC database

Information Models

HL7 2.4 specifies a goal detail segment (information model for a goal instance) that includes the data necessary to add, update, correct, and delete the goals for an individual (Table 4). [10] Elements in the message detail segments include those related to the goal name or identity (e.g. name of goal, target type [patient, caregiver, etc.]), other elements about the goal that may be specific to the organization (e.g., discipline responsible for managing the goal), and elements related to the instance of a goal (e.g., time/date the goal was established). The goal identity includes an institutional code, text string, and coding system.

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<Goal 123>^<Patient will remain free of
signs or symptoms of blood glucose
alteration>^ <PCDS>
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HL7 3.0, an evolving standard, is based upon a reference information model (RIM). A discussion of the RIM is beyond the scope of this paper, however, two aspects of the model are particularly relevant to the discussion of goals: relationship between observation action and observation result and use of "mood" codes. Based upon the Unified Service Action Model (USAM), the observation action and observation result in the RIM "are modeled as being the two sides of the same concept, just like the two faces of a coin are not separable from each other". [22] In the context of the RIM, mood "represents a particular set of inflectional forms of a verb to express whether the action or state it denotes is conceived as fact or in some other manner (as command, possibility, or wish)". [12] The HL7 Patient Care Committee has proposed Goal as a mood code as strategy for differentiating between actual and expected observations. The goal of a score of 5 on Knowledge: Diabetes Management versus the same term and value as an actual finding would be differentiated by the mood of Goal in the former observation.

Terminology Models

Two terminology models may have some relevance to the formal representation of goals: LOINC and ISO Reference Terminology Model for Nursing Diagnoses.

The LOINC database was originally designed to create fully-specified names for laboratory observations. [5] A primary focus has been to support the names for name-value pairs in HL7 messages. More recently the database has been expanded to include clinical observation names (Table 5) including those related to nursing assessments (e.g., HHCC, Omaha). [9] The values associated with the clinical observation names are not part of the LOINC semantic structure, but are included as descriptive fields in the database. For example, the value set for the *expected* or *actual* outcome associated with the HHCC term of Noncompliance with Dietary Regimen is Improved, Stabilized, or Deteriorated. Although HHCC was designed as a terminology to

report both expected and actual values, the LOINC semantic structure was not designed to differentiate between actual and expected observations (i.e., goals) and is currently insufficient to do so. Possible strategies related to using LOINC for representation of goal statements might include extension of property to include the notion of goal or to rely upon a construct such as mood code in the information model to differentiate between actual and expected observations.

Table 4. HL7 Goal Detail Segment for Version 2.4

Element Name	Data Type
Goal Name-related[1]	
Goal ID	Coded Element
Goal Target Type	Coded Element
Institution-related[1]	
Goal Classification	Coded Element
Goal Management Discipline	Coded Element
Goal Instance-related[1]	
Action Code	HL7 Code
Action Date/Time	Time Stamp
Goal Instance ID	Entity Identifier
Episode of Care ID	Entity Identifier
Goal List Priority	Numeric
Goal Established Date/Time	Time Stamp
Expected Goal Achieve Date/Time	Time Stamp
Current Goal Review Status	Coded Element
Current Goal Review Date/Time	Time Stamp
Next Goal Review Date/Time	Time Stamp
Previous Goal Review Date/Time	Time Stamp
Goal Evaluation	Coded Element
Goal Review Interval	Timing Quantity
Goal Evaluation Comment	String Type
Goal Life Cycle Status	Coded Element
Goal Life Cycle Status Date/Time	Time Stamp
Goal Target Name	Extended Person Name

[1] *Specified divisions are those of the authors, not of HL7.*

Another terminology model of possible relevance for formally specifying goals is the ISO Reference Terminology Model for Nursing Diagnoses (Figure 1) currently under review as an ISO Technical Committee 215 Committee Draft. [21]

Table 5. Semantic Structure of Clinical LOINC for Standardized Assessment Observations

COMPONENT – Attribute of a patient or an organ system within a patient; name of the scale item
PROPERTY - kind of quantity related to a substance
  Finding – atomic clinical observation, not a summary statement as an impression; can be professional or non-professional; can be of any scale type
  Impression – a diagnostic statement, always an interpretation or abstraction of some other observations and almost always generated by a professional
TIMING - interval of time to which the measurement applies
  Point - single point in time
  Interval - more than a single point; specified in minutes, hours, days, weeks, months, etc.
SYSTEM (SAMPLE) – individual or group who is the object of the measurement (e.g., patient, family, community)
SCALE – type of scaling used in the measurement of the item (quantitative, ordinal, nominal, narrative)
METHOD – method of completing the measurement
  Observed (professional's rating)
  Reported (patient/client self-report)

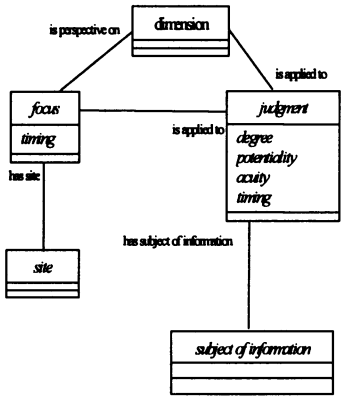

Figure 1. ISO Reference Terminology Model for Nursing Diagnoses

In this model, the required semantic structures are Focus and Judgment. Focus is defined as an area of attention. Judgment is an opinion or discernment related to a focus or dimension. A descriptor for Judgment may be qualified by degree, potentiality, timing, and acuity. Descriptors of potentiality (possibility) include, but are not limited to: risk for, actual, possibility of, and potential. The ISO model was not conceptualized as a terminology model for goals. However, the potentiality qualifier for judgment may hold some promise as a semantic structure appropriate for the descriptor of "Goal of" to differentiate between actual and expected or desired nursing diagnoses.

Table 6. Examples of Goal Dissections using ISO Model with "Goal of" Potentiality Qualifier

Glycated hemoglobin <7	
Focus	Glycated hemoglobin
Dimension	N/A
Judgment: Degree	<7
Judgment: Potentiality	Goal of
Subject of information	Patient (implicit)
Urine will test negative for glucose or ketones.	
Focus	Urine ketones, urine glucose
Dimension	N/A
Judgment: Degree	Negative
Judgment: Potentiality	Goal of
Subject of information	Patient (implicit)

DISCUSSION

As with other types of healthcare concepts, formal representation of goal statements raises issues of which semantic structures should be represented in the information model versus the terminology model. Clearly data about the instance of a goal (e.g., review date) belong in the information model, however, data about Goal Target Type (e.g., patient, family caregiver) might arguably be represented in either the information or the terminology model. The larger issue, however, relates to the notion of goal as a

mood that is post-coordinated with a finding in the information model. Consequently, it may be possible to use a terminology (e.g., LOINC, NOC, Omaha) that does not differentiate between expected and actual findings in its explicit or implicit terminology model. While decreasing the issue of combinatorial explosion of the number of terms, in the absence of a universally-shared reference information model, this approach may pose a threat to semantic interoperability. The trend in healthcare is toward concept-oriented terminologies with broad coverage for the healthcare domain, e.g., SNOMED RT and SNOMED Clinical Terms (CT). [23, 24] To date, there is no standard for a terminology model to inform the incorporation of goals and outcomes into such terminologies. The Clinical LOINC semantic structure and ISO Reference Terminology Model are currently insufficient to differentiate between actual and expected findings, but offer an excellent starting point for further evaluation and revision.

Acknowledgments

The preparation of this manuscript was partially supported by NIH P20NR07799 (S. Bakken, PI). We thank James Campbell, MD, for his comments on an early draft of this paper.

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