Modeling nursing interventions in the act class of HL7 RIM Version 3

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Abstract

The proposed Health Level 7 Reference Information Model (HL7 RIM) Version 3 is the foundation for expressing data to be communicated across health care information systems. The general objective of this analysis was to examine whether the RIM supports the expression of nursing interventions, considering both terminological and structural perspectives. The Nursing Terminology Summit Interventions Group focused on patient education about breast cancer, an intervention that differs sufficiently from other medical processes already considered by HL7 and represents issues surrounding both definition and execution of nursing process. Relevant actors, actions, and action relationships were culled from use cases and modeled into the proposed RIM structure and attributes by using modified instance diagrams. This method was effective and reproducible, and the RIM proved to be an adequate model for supporting breast cancer education. Additional interventions must be studied to fully assess the adequacy of the model to support all aspects of nursing process and terminology.

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1. Introduction

The purpose of this paper is to describe the challenges and discoveries of the Interventions Group of the Nursing Terminology Summit as the group developed a method for evaluating whether the Health Level 7 Reference Information Model (HL7 RIM) could be used to represent nursing actions (interventions). Because the HL7 RIM defines the underlying model used to guide the definition of messages to be exchanged between health care information systems, it is critical that it accommodate these data.

The Nursing Terminology Summit [1–4], held annually since 1999, brings together international interdisciplinary experts on nursing terminology. During the meeting in 2000, participants agreed it was important to harmonize the emerging nursing terminology models with the emerging HL7 RIM Version 3 [5] (www.HL7.org). A subgroup of Summit participants—vendors, clinical system implementation specialists, physicians, nurse providers, and researchers—volunteered to evaluate the RIM against nursing intervention scenarios to elicit issues relevant to both the reference
information model and the reference terminology model. However, efforts to examine simultaneously both the reference terminology model as a way to express nomenclatures (such as those recognized by the American Nurses Association) and the RIM proved to be a complex task that required a sequenced approach. Examining the extent to which nursing intervention processes could be structured within the RIM was considered to be an important first step toward understanding the associated terminology issues.

2. Background

HL7 is an accredited American National Standards Institute Standards Developing Organization (SDO). This SDO defines the HL7 standard protocols for interfacing medical data between information systems. These HL7 protocols define the specific messages necessary to communicate clinical data.

HL7 Version 3 is proposed as a testable standard that, when implemented, will enable the sharing of consistent and comparable data across clinical information systems by providing an explicit representation of the information carried in the fields of HL7-compliant messages. Central to the Version 3 standard is the RIM, often represented as a high-level class diagram in Unified Modeling Language (UML) [6]. It is important to determine whether the RIM can accommodate the expression of domain-specific messages such as those related to nursing interventions.

Of particular interest to the Nursing Interventions Group was the Act class of the RIM, used to represent intentional acts that are performed to benefit the patient and associated clinical activity. Procedures, observations during an assessment, and administering medications are examples of Acts. Like a verb, an Act is expressed with moods that tell the user whether the Act might happen (definition), is requested to happen (order), is planned to happen (intent), is wished for (goal), or actually happened (event). The mood of an Act is used to give the same range of expression to Acts that various forms of verbs give to sentences [7]. The broader portion of the RIM that represents the type of action, the participation of the actor, and the objects or targets that the action influences were also considered during this effort.

Members of the Interventions Group posed the question, “Is the expressiveness of the Act class, along with its moods, subclasses, and published vocabulary domains, sufficient to define a structure for communicating nursing activities?” Because of its abstract nature, it was not readily apparent that the Act class of the RIM could support the complexities of nursing interventions as discussed in the HL7 Patient Care Technical Committee [8].

3. Formulation process—use case models

The group focused on modeling the nursing intervention of patient education about breast cancer against the RIM [9]. This intervention represents a “core” nursing action, is sufficiently complex, and can be generalized to other patient education interventions.

Use cases were selected as the underlying approach for this modeling effort because the basic structure of use cases is process flow. They were used commonly to describe an information system’s behavior in response to an interaction from a stakeholder or user [10,11]. Ivar Jacobson, who wrote extensively on use case development, described the concept of documenting business processes through use cases. Jacobson [12] defined a use case (in a business process) as a sequence of transactions in a system whose task is to yield a result of measurable value to an individual actor of the business system. The use case, therefore, provides a mechanism to describe the event flows of the nursing process for patient education, including the actors’ or nurses’ interactions with patients and family members or information systems at a high enough level of detail to be useful for modeling nursing interventions within the RIM.

In this instance, use cases offered several advantages for describing patient education interventions. They were flexible enough to do the following:

- Describe the patient education process from defining a standard patient education plan to delivering the education and evaluating patient outcomes.
- Represent both the process and intervention content.
- Facilitate discussion and agreement regarding intervention flow and content.
- Accomplish validation without extensive education on use cases or diagramming.
- Have a semi-structured, concise format that facilitated modeling into the RIM.

The use cases developed were written in a semi-structured text format, were goal oriented, contained actors, described a sequence of events, and defined both the conditions that must be met before the process could begin and the resulting state when the process was completed. In this paper, the term “use case” is used in its broad sense and may include many smaller use cases.

Six use cases were required to represent the nursing acts and event flows related to the patient education process (Table 1). The goals of the use cases ranged from creating a standard patient education plan through determining the effectiveness of the education plan for a population of patients.

The use cases focused on identifying information that would ultimately be exchanged among systems, using an example of the intervention content based on research by Hughes et al. [9] on patient education during care for cancer. As such, the intent of the group was that each use case could be viewed as independent of any
Table 1
Breast cancer education use cases

<table>
<thead>
<tr>
<th>Use case</th>
<th>Goal</th>
<th>No. of steps</th>
<th>Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Create a standard education program for persons with breast cancer</td>
<td>13</td>
<td>Describes identifying best-practice recommendations, drafting initial template, iterative review, and committee approval</td>
</tr>
<tr>
<td>2</td>
<td>Customize a standard education plan for a patient and communicate the plan to the health care team</td>
<td>13</td>
<td>Describes selecting appropriate template, assessing patient, customizing plan to meet patient's needs, and reaching consensus on the plan</td>
</tr>
<tr>
<td>3</td>
<td>Deliver and document education and the patient's or caregiver's response</td>
<td>8</td>
<td>Describes education intervention, documentation, patient response, completion status, and variance data</td>
</tr>
<tr>
<td>4</td>
<td>Update and modify the initial education plan on the basis of continuing therapies and patient's and family's responses</td>
<td>8</td>
<td>Describes modifying plan by adjusting intervention timing, adding, modifying or inactivating planned interventions, and reaching agreement on modified plan</td>
</tr>
<tr>
<td>5</td>
<td>Determine if the planned education was successfully executed for the patient</td>
<td>8</td>
<td>Describes completing the plan documenting variances with plan, recording results, and identifying continuing needs</td>
</tr>
<tr>
<td>6</td>
<td>Determine the effectiveness of the standard education plan for an aggregate of patients</td>
<td>8</td>
<td>Describes aggregation of data for reporting effectiveness of plan, summary comparisons, and pattern analysis; includes proposed modifications to standard plan, research on proposal, and committee approval</td>
</tr>
</tbody>
</table>

particular software application, represent information generated from and stored in a variety of health care systems (e.g., systems for clinical care management, ambulatory care management, home care, case management, and decision support), and include variations in time and setting of care. To maximize the general nature of these use cases for modeling the RIM, the group determined that within each use case's sequence of events, the following characteristics should be indicated: various health care providers performing interventions, recipients of interventions in different roles, a variety of teaching methods, interventions sequenced to elicit dependencies, interventions based on goals for specific patient outcomes, interventions delivered in different phases of care, and interventions spanning different phases of the care continuum. For example, the intervention could start pre-operatively and continue during the post-operative period. Interventions were first planned and then delivered in subsequent phases, and some interventions spanned different care settings such as acute care, ambulatory care, and home care.

The following is an example of a fully specified use case. Use case 1 describes the process for creating a breast cancer education plan, which is the first logical step. It defines the goal, pre-conditions, sequence of events, and post-conditions for establishing a breast cancer education plan.

Goal. Establish a standard breast cancer education plan.

Pre-conditions. (1) Decided the context for which the plan will be used. (2) Formed an oncology education standards committee.

Sequence. (1) All members of committee bring standards of care for education from respective disciplines. (2) Committee performs literature review to collect current education research and best practices. (3) Committee researches external requirements from organizations such as the Joint Commission on Accreditation of Healthcare Organizations, Centers for Medicare and Medicaid Services, US Food and Drug Administration, National Cancer Institute, and large-volume and third-party payers. (4) Committee collects internal policies, requirements, and existing educational materials. (5) Committee researches patient education materials prepared by other organizations such as the American Cancer Society, Oncology Nursing Society, or third-party vendors. (6) Committee gains agreement if standard terminology will be used. (7) Committee author drafts initial template for educational interventions. The draft includes the intervention, method, responsibility, intensity, measurement criteria, and an example of expected outcome. (8) Plan includes sequencing based on time and branching algorithms based on clinical findings or outcomes. Plan is communicated on the basis of different decision criteria with use of events or time. (9) Committee follows an iterative review process with team members. (10) Committee evaluates compliance with standards. (11) Committee agrees on final education plan. (12) Committee provides links from standard plan to education knowledge bases. The links should be context specific for the overall plan and components of the plan. (13) Committee reviews and modifies on a regular basis.

Post-conditions. (1) Standard Breast Cancer Education Plan is approved. (2) Education plan is added to the repository of education plans.

To assure that all use cases reflected clinical realities, they were validated in two ways. First, the intervention content source was based on empirical research on patient education during care for cancer, i.e., an enumer-
ation and analysis of the varied interventions used by nurses to describe patient education for patients with newly diagnosed cancer [12]. Second, advanced practice nurses who specialize in the care of persons with breast cancer and who work in various roles and practice settings were interviewed about the nature and types of messages they need to send to and receive from others in the course of communicating about the design, delivery, and quality monitoring of patient education. Reviewers included breast cancer specialists at Mayo Clinic, clinicians and graduate students at Loyola University, and pharmacists at Siemens. Finally, the HL7 Patient Care Committee also reviewed the use cases.

4. Formulation process—information models

The group searched for a simple method for modeling the use cases against the HL7 RIM to bring both the nursing care process and the terminology considerations to the forefront. However, a method by which to evaluate systematically the Act portion of the RIM against specific use cases was not available in the extant literature or in HL7 documentation. Also, a common computer-aided software engineering tool was not available to the group, so a more basic approach was necessary. Initial attempts with Excel spreadsheets failed to demonstrate or allow an actual visualization of Act relationships.

The method by which the group was able to test each use case against the HL7 RIM involved “reading” each use case into one or more instance diagrams of the RIM. To make these instance diagrams easily accessible to group members, an instance diagram template, which is graphically similar to UML-generated models, was generated in Microsoft PowerPoint and distributed among group members (Fig. 1). This method provided the foundation for this effort, allowing group members to focus on identifying those nursing actions and action relationships important to breast cancer education and to identification of terminology requirements. The artifacts provided a simple and reproducible template for dissecting the use cases into an orderly and systematic structure for modeling the HL7 RIM. The templates were used as a framework for translating the use cases into discrete actions or events, while providing a mechanism for expressing the relationships between these actions or events. Intervention group members walked through each use case, decomposing each one into Acts, Act attributes (e.g., code, moodCode, typeCode, and statusCode), and Act relationships. Actors and their roles were identified. Using the instance diagram template, group members worked through multiple iterations of creating Act and Act relationship diagrams and models and of assigning values to attributes within the classes of the RIM relevant to each of the six use cases. The values assigned to each attribute should, ideally, have been retrieved from published nursing terminologies, but work to structure these terminologies to fit HL7 Version 3 messaging formats has yet to be completed.

After several cycles of review and revision within the intervention work group, external experts from HL7 validated the modeling process and results.

This process helped the group identify important content to be shared among systems, while eliciting requirements and considerations related to nursing terminology. The examples that follow, which focus on a few key steps from select use cases, were particularly useful in highlighting terminological and structural

![Fig. 1. Modeling acts in the HL7 RIM: instance diagram template.](image-url)
findings related to the ability of the RIM to support the communication of data describing nursing interventions across information systems.

- Use case 1: creating a standard breast cancer education plan, step 7.
- Use case 3: delivering patient education, steps 1, 2, 3, and 5.
- Use case 6: analyzing the effectiveness of the standard education plan for a population of patients.

Use case 1 demonstrates the structure of the standard breast cancer education plan, as it would be represented in the RIM (Fig. 2).

In step 7 of use case 1 the committee drafts the initial education template. This model illustrates that a single Act of breast cancer education can have multiple active participants (a committee, as author of the education plan, and caregivers, who perform interventions defined in the education plan) and multiple target participants such as caregiver and patient. It also shows how to model both the education provided as well as the outcome of that education in a single template. Therefore, the model illustrated in Fig. 2 validates that the HL7 RIM captures the discrete components and semantic structure (implied relationships and dependencies) of nursing actions and outcomes, both of which are important to record within and communicate across information systems.

The model can be read as follows:

The Act (drafting or creating the breast cancer education plan) is performed by an entity in the role of committee, participating in this Act as an author of the breast cancer education plan that will be used by the caregiver (target). The breast cancer education plan is in “definition” mood in the business cycle, with a status of “new” and an activity time of “any.” The breast cancer education plan contains (Act relationship) many procedures or actions (e.g., dietary education, medication education—chemo drug) that are also in “definition” mood in the business cycle, with a status of “complete” (the draft is completed), an activity time of “any,” and a method for delivery (video, etc.). Each procedure has an outcome (class code of “observation”), with the mood of “goal” and a value that defines the expected outcome. This example shows that an Act can have multiple active participants and multiple target participants, with their specific role distinguished in the type code in the respective instance of the participation class. It also illustrates that the committee is the author of the breast cancer education plan while the caregiver is the performer of the education.

A second example, step 1 of use case 3, demonstrates how the execution of the education plan is modeled (Fig. 3).

Step 1 of use case 3 is focused on execution of the intervention defined in the standard breast cancer education plan. It should be noted that this model for “delivering education” has the same structure as the model for “drafting the initial education template” (Fig. 2). There is an important symmetry between the definition of an education plan and the execution of that plan. The model for creating a breast cancer education plan is essentially replicated with different mood and status designations when such a plan is implemented.

The model can be read as follows:

This step is focused on the registered nurse (RN) and/or nurse’s aide executing and documenting the education given. The Act (breast cancer education) is performed by an entity in the role of RN, who is participating in thisstep. Fig. 2. Use case 1. Creating a standard breast cancer education plan: step 7, draft initial education template.
Act as a performer providing breast cancer education to the target (patient). The Act of education falls into the class code of "procedure." The specific procedure Act is breast cancer education, which has the mood of "event." The status of this activity is "complete," and the activity time is "14:00." The breast cancer education plan contains various interventions (e.g., dietary education, medication education). The relationship "contains" links the various interventions into one cohesive plan.

An Act can have multiple active participants and multiple target participants, with their specific roles distinguished by the type code in the respective instance of the participation class. In this step, the intervention is simply recorded as being given, without regard to portion completed or outcomes.

Steps 2, 3, and 5 of use case 3 (Fig. 4) focus on documenting that breast cancer education was given, the percentage completed, the expected and actual outcomes, and the variances (the difference between expected and actual outcomes). The procedure Act (breast cancer education) is performed by an individual in the role of RN, who is participating in this Act as a per-
former providing breast cancer education to the target (patient). The breast cancer education is an event with a status of “active” and an activity time of “15:00.” Documenting the percentage completion for the education was modeled by using portion complete, a new Act attribute for defining completion status. It is “mostly” completed. The RN documents the patient response to education provided through observations that depict expected outcomes, actual outcomes, and variances. Expected outcomes, actual outcomes, and variances all have the mood of “goal,” with an “active” status, an activity time of “any,” and values that define the specific expected outcomes, actual outcomes, and variances.

To demonstrate a completely different perspective, use case 6 (Fig. 5) is included to show the need for and means to communicate aggregate retrospective information between systems. Modeling of this use case brought to the forefront the need to communicate the effectiveness of the standard patient education, as well as the ability of the HL7 RIM to support this information.

Use case 6 focuses on analyzing the effectiveness of the standard education plan for a population of patients. In the use case, a series of statistics are generated and analyzed, and modifications are made to the standard plan on the basis of the resulting information. The step in the use case, modeled in Fig. 5 and described in the following paragraph, depicts the communication of the total number of patients enrolled in standard breast cancer education, the total number eligible for education, and the percentage enrolled.

The Act class procedure identifies the completed breast cancer education plan that is being evaluated, and is in the “event” mood, is performed by an entity in the role of “committee” who is making an evaluation of the target “group,” which is the population of breast cancer patients. Each “observation” Act identifies a statistic to be calculated (number eligible, number enrolled, and percentage enrolled), and is in the mood “event” and has a status of “completed” and an activity time of “any.” The values would contain the actual calculations. The “calculates from” Act relationships identify the inputs to the calculation. The Acts are associated using the “evaluates” Act relationship.

5. Discussion

Of primary importance to this effort was the development of techniques for representing nursing interventions in use case form and modeling use case content with instance diagrams. The methods we described were effective in helping the group evaluate the ability of the HL7 RIM to accommodate the syntactic and semantic definition and communication of data related to breast cancer education. Importantly, the modified instance diagrams provided an easy-to-learn and easy-to-read diagram, which nursing domain experts not extensively trained in UML could use to express the nursing process and to explore the relationship between the HL7 RIM and this process. In hindsight, utilizing a commercially available modeling tool may have been more efficient, but the use of Microsoft Power Point did provide an effective tool for the compact display of the resultant models.

A few issues were identified that reflect on the reliability and the reproducibility of the process. The modeling effort required domain knowledge related to the scope of nursing practice, an understanding of the HL7 RIM, and expertise in software application design and

![Fig. 5. Use case 6. Determine effectiveness of education plan: steps 1a, 1b—population eligible versus enrolled.](image-url)
system interfaces. Initially, the HL7 RIM was a moving target under continuous refinements and enhancements, which complicated modeling efforts. Updating models from the most recent versions of the RIM was a time-consuming and continual challenge, because they had to be adjusted constantly to reflect RIM changes. The second issue focused on the evolving definitions and potential misunderstandings that arose because of the complexity and subtleties of the RIM vocabulary and its attributes. The group met this challenge by maintaining continuous contact with persons actively involved in the RIM’s evolution. Since the conclusion of the modeling effort, the RIM and HL7-maintained terminology tables have stabilized. Templates, domain examples, and style guides on the Web would facilitate understanding the abstract nature of the RIM.

Many other important findings resulted from this initial modeling effort: (1) implications for the HL7 RIM, (2) implications of the HL7 RIM for terminology modeling and domain terminologies, and (3) implications for existing nursing terminologies.

5.1. Implications for the HL7 RIM

A primary finding (and the primary objective of the effort) was that the HL7 RIM structurally accommodates the nursing interventions described in the six breast cancer education use cases. We used existing classes and attributes of the RIM to describe and classify the actions and outcomes contained in the use cases and to illustrate the relationships between them. Given the general nature of the RIM, we expect that it will accommodate other education-related interventions and other types of interventions as well. However, this must be the subject of additional evaluation efforts.

Second, within the Act class of the RIM, there is no specified way to model the partial completion of an event (e.g., expressing “partly completed” or “mostly completed”). For example, use case 3, executing the education plan, stated if an education intervention was partially complete, the percentage completion should be captured. Therefore, the intervention could carry over and get updated until completed or the RN modified or ended it. This aspect of the use case could not be modeled. It was determined that an attribute of Act was needed to account for this process. This concept is an essential component of interdisciplinary documentation and needs to be communicated along with the status of an Act. Since the RIM is ultimately used to generate messages across systems including across settings of care, the specific completion status of an intervention is critical. Not having this attribute could result in misleading information. This finding underscores the need to validate the RIM with scenarios generated by domain experts to account for such variations in the process of delivery care.

Third, it became apparent while reading the use cases into the instance diagram templates that they identified fairly specific nursing concepts, and the current value sets within the HL7 RIM do not support this. Essentially, the RIM value sets do not have adequate nursing representation. For example, role.type_cd contains only “nurse.” The many other more specific nursing roles are missing (e.g., nurse practitioner, identification of clinical specialty). Similarly, Observation.method_cd has only laboratory and ultrasonographic methods, which are inadequate for representation of the various methods used by nurses and other caregivers. A subclass of Act may be necessary to accommodate additional attributes related to nursing activities for indirect care (e.g., utilization review, administration, and aggregate analysis). For example, use case 6 demonstrated a retrospective aggregate view of the effectiveness of the breast cancer education plan. Predominant statistical measures were communicated between systems. While this could be modeled using the Act class, type codes to label the measures, and derived expression for the formulas, the content seemed incongruent with the other attributes and values for the Act class. A new subclass with related attributes would be more descriptive and consistent with the process of analyzing data. However, this must be the subject of additional efforts for further investigation and clarification.

5.2. Implications of the HL7 RIM for terminology modeling and domain terminologies

Terminologies cannot be freestanding. They must ultimately adhere to many of the same or similar structural rules that apply to information models, such as the HL7 RIM. The HL7 RIM is the underlying information model for the evolving HL7 Version 3 messaging standard for inter-system communication. Its structural rules must be accommodated in any new nursing reference terminology, and even existing terminologies may need to be adjusted to accommodate the rules of the information model. The semantic structures and concepts within the interface and reference terminologies and administrative and statistical classifications must be able to describe the linkages between actions and between actions and outcomes, as expressed in the information model.

It should also be noted that, as is the fundamental intent of the RIM, the definition of an interventional nursing plan and the execution of that plan are symmetrical. Within the information model, the definition of an interventional plan or protocol such as breast cancer education is essentially replicated with different mood and status when such a plan is implemented. Therefore, the terminological structure and content of a terminology model should accommodate taking on the mood of the information structure in which it will ultimately reside.
5.3. Implications for existing nursing terminologies

We did not determine whether values representing the patient education concepts exist in any current nursing terminology system. However, the HL7 RIM is emerging as an underlying information model for the evolving HL7 Version 3 messaging standard for intersystem communication. It is critical that nursing terminologies are expressed within a structure that complements the RIM classes, subclasses, and attributes. Additional evaluations are needed to determine the extent to which existing content of nursing terminologies covers the concepts identified in these use cases and to address the issues such as data type and the semantic structural consistency between the information and terminology models.

6. Conclusion

While we have learned a great deal from this study, additional work is required to understand the necessary intersection and interaction of terminology and information models. As stated in the International Organization for Standardization (ISO) working document on “Health Informatics—integration of a reference terminology model for nursing,” a potential use for a reference terminology model is to “provide a language to describe the structure of nursing diagnosis and nursing action concepts in order to enable appropriate integration with information models (e.g., Health Level 7 Reference Information Model)” [13]. Specifically, it is necessary to ensure that the HL7 RIM, as a generic framework for supporting standard intersystem communication for health care data, captures the semantic structure for nursing actions. This will help ensure that nursing terminologies (including the reference terminology) are integrated into the larger medical information system and intersystem data flows and that they will serve as a viable language of communication.

7. Next steps

Along these lines, at least three steps are immediately evident.
1. Model other general categories of nursing interventions (meta-interventions) to illustrate the reliability and validity of breast cancer education as being representative of a wider set of nursing interventions for testing the viability of the HL7 RIM.
2. Develop a framework and approach for testing how existing nursing terminologies fit into the models developed with this initial modeling effort and into the HL7 RIM. An analysis of how the existing nursing terminologies layer into these information models has not been attempted, but from a cursory glance, gaps do seem to exist, at least for codifying the actions expressed by the breast cancer education use cases. The likely approach involves use of the rich domain knowledge expressed in each of the existing terminologies to create an analysis model of their domain, synthesizing and consolidating these separate models into the single reference terminology model and then modeling the results to the RIM.
3. Determine what data are essential to support the nursing process and to communicate with other stakeholders in patient care and what data must ultimately be codified and included in nursing terminologies. The use cases and information models generated during the effort identify a wide variety of actions and relationships that go beyond existing nursing terminologies. Therefore, a priority is to identify what data need to be collected and communicated to determine how precise the data need to be, both to describe the nursing process and to support the aggregation of data to assess overall effectiveness of the processes.

It is important that this work continue. These steps will further define a complete nursing domain model within the HL7 RIM, which will facilitate the sharing of consistent and comparable of data describing nursing across patient care information systems. The focus of this initial work was to test the ability of the RIM to message nursing activities. Work must now develop RIM content for setting the standards for nursing messages.

In summary, this effort indicates that the HL7 RIM does support the complexity inherent in nursing interventions, at least those complexities posed by a representative “core” nursing action such as breast cancer patient education. However, some enhancements are necessary to fully support nursing interventions. A new attribute is necessary to record the partial completion of an event, and RIM value sets must be enhanced for better nursing support. Recommendations were made to the HL7 Patient Care Committee accordingly. From a terminology perspective, the structural rules of the RIM, as the reference information model, will affect how nursing knowledge is recorded and communicated. Also, these rules must influence the semantic structures and concepts within the existing and new terminologies that define the content of those communications.

The process used to develop this assessment was effective and reproducible. Use cases provided an effective means of describing the patient education process, and the RIM instance diagrams provided an effective visual means for non-technical, nursing domain experts to model their knowledge of this process in RIM terms and to communicate results among the geographically distributed team. Others in the field can use a similar approach to express and model other aspects of nursing process for the purpose of creating a more complete
domain information model within the HL7 RIM and enabling complete and consistent communication of nursing actions among patient care information systems.

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