

Development and Validation of Data Specifications for Nursing Problems in Maternal Nursing Care

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Abstract

The aims of this study were to develop data specifications for nursing problems related to maternal nursing care and to test the applicability of those data specifications. First, we identified focus concepts and characterizing concepts of nursing problems by analyzing nursing-problem statements from nursing records, reviewing the literature, and interviewing experts. Second, we identified relationships between the focus concepts and characterizing concepts. Third, value sets of characterizing concepts were identified and types and cardinalities of the characterizing concepts were defined based on those value sets. Finally, data specifications were evaluated by a group of experts and by applying them to published case reports. The adequacy of the characterizing concepts and value sets, and the types and cardinalities of the characterizing concepts were validated. In total, 58 data specifications were developed with 53 characterizing concepts, relationships, and value sets. Their validity was established by the experts and by their application to case reports. The data specifications developed in this study can ensure that electronic health records contain meaningful and valid information, and support the semantic interoperability of nursing information.

Keywords:

Medical information standards, Nursing diagnosis, Knowledge representation.

Introduction

The potential benefits of electronic medical records include improvements in patient safety and quality of care, and reducing the number of medical errors. These benefits depend on data interoperability; exchanging and sharing data is most effective if the data are exchanged and shared in a semantically interoperable manner.

Semantic interoperability means ensuring that the precise meaning of exchanged information is understandable by other systems or applications not initially developed for this purpose [1]. Data being exchanged must be structured and coded to facilitate their complete understanding by computer systems. Complete interoperability depends on a detailed clinical data

model that is bound to terms and codes from a standard coding system.

Several different approaches have been used in the development of interoperable models. Intermountain Healthcare has been developing Clinical Element Models for over 15 years [2]. The Research and Development Center for Interoperable Electronic Health Records (EHRs) in Korea is developing a Clinical Contents Model [3]. The developers of the openEHR used archetypes and templates as interoperable models [4]. A group in the UK National Health Service is developing models using a process called the Logical Health Record Architecture. Within the Health Level Seven community, a detailed Clinical Document Architecture is being developed as an interoperable model [5]. However, these efforts in model development are limited to the domain of medical knowledge.

Whilst the importance of developing a nursing constraint model has been addressed by nurse informaticists [6], there are few reports on this topic in the nursing literature. Arche-types of nursing problems for breast cancer patients have been developed and tested in Korea [7], and data specifications for stroke patients have been developed in The Netherlands [8].

The aim of this study was to develop data specifications to represent clinical information in a meaningful way so that data can be accumulated and integrated in a clinical practice environment where the level of nursing-problem documentation varies. We looked at the nursing problems of pregnant women who were hospitalized to give birth since this cohort is homogeneous in terms of gender and age and exhibits comparatively few comorbidities and complications. Once data specifications are developed, we plan to explore the possibility of expanding this work and applying it to other areas of nursing.

Materials and Methods

Extraction of focus concepts of nursing problems

We extracted nursing statements describing patient signs and symptoms, and nursing diagnoses from the electronic nursing records of the 118 women who were hospitalized to give birth from October 1 to October 31, 2008 at a tertiary teaching hospital in Korea. We identified focus concepts from these statements. For example, we extracted a focus concept 'pain' from

the nursing-problem statements ‘mild back pain’ and ‘continuous back pain’. We also reviewed the maternal nursing literature to supplement the focus-concept list. The extracted focus-concept list was evaluated and confirmed by a group of experts that comprised a head nurse in maternal nursing, three nurses with master’s degrees in maternal nursing, and four nurse experts each with more than 7 years of clinical experience in maternal nursing.

Identification of characterizing concepts

We identified the concepts needed to describe the focus concepts in more detail by analyzing nursing statements, reviewing the literature, and consulting staff nurses. For example, characterizing concepts such as ‘anatomical site’, ‘severity’, and ‘frequency’ were identified from the nursing statement ‘continuous mild back pain’. These characterizing concepts were confirmed by 8 nurse experts and named using The Conceptual Framework for Patient Findings and Problems in Terminologies published by the ISO/TC 215 [9], Archetype by the *openEHR* [4], Attributes of SNOMED CT [10], and the Clinical Contents Model developed by the Research and Development Center for Interoperable EHRs [3].

Development of data specifications

Data specifications were developed using focus concepts, characterizing concepts, the relationship between focus concepts and characterizing concepts, and the types, value sets, and cardinalities of characterizing concepts.

Validation of data specifications

Data specifications were validated by experts and by their application to published case reports. A group of experts was asked to evaluate whether the focus concepts were adequate, the characterizing concepts were clearly represented, the relationships between core concepts and characterizing concepts were adequate, the value sets were complete, and the types and cardinalities of the characterizing concepts were correct. The expert group comprised three doctoral students in nursing informatics, one head nurse with experience in informatics and maternal care, two informatics nurse specialists, and two maternal nurses each with more than 7 years of clinical experience.

Data specifications were also evaluated using two case reports published in an academic journal. We identified focus concepts, characterizing concepts, and value sets from the case reports, and mapped them with the developed data specifications to evaluate their coverage. The cases we used for validation were aplastic anemia in pregnancy [11] and stimulating the onset of labor [12]. Data specifications of menstrual history, gravida, parity, abortion, Bishop Score, uterine contraction, and rupture of membranes were validated with the case reports.

Results

Extraction of focus concepts of nursing problems

Forty-one core concepts were extracted from 711 days of nursing records related to 118 pregnant women who were hospital-

ized to give birth. Examples of focus concepts identified from the nursing records included concepts unique to maternal nursing such as uterine contraction and lochia, and general nursing concepts such as gas emissions, constipation, and pain. In addition, 12 core concepts were identified from a literature review. Concepts such as Bishop Score, guilt, and inverted nipples were identified through a literature review. Five more concepts were identified from the experts’ evaluation: two experts suggested body weight and abdominal circumference, and one expert suggested abscess, falling, and arrhythmia.

In total, 58 focus concepts were identified. These focus concepts included not only physical signs and symptoms such as dyspnea and seizure, but also psychosocial problems such as grief, guilt, depression, and parent role. Furthermore, there are complex focus concepts that comprise more than one focus concept, such as vital signs, which comprise systolic blood pressure, diastolic blood pressure, pulse, respiration, and body temperature.

Identification of characterizing concepts

Thirteen characterizing concepts were identified by analyzing nursing statements. For example, we identified ‘severity’ with a value set of ‘absent’, ‘mild’, and ‘severe’ by analyzing nursing statements such as ‘severe pain’, ‘mild pain’, and ‘no pain’. The characterizing concept ‘pain character’ was identified with the value set of, for example, ‘sharp’, ‘burning’, and ‘fulgurating’, by analyzing nursing statements such as ‘burning pain’, ‘sharp pain’, and ‘fulgurating pain’.

Thirty-four characterizing concepts were identified from a literature review, such as ‘intensity’ with a value set of ‘strong’ and ‘weak’. In addition, six characterizing concepts were identified by the expert group, such as ‘level’ with a value set of ‘-’, ‘±’, ‘+’, and ‘++’ to describe the presence and amount of protein or ketone in the urine. In total, 53 characterizing concepts were identified.

Development of data specifications

Data specifications for 58 focus concepts were developed by relating focus concepts to characterizing concepts with data types, cardinalities, and value sets. The lochia data specification is listed in Table 1 and presented diagrammatically in Figure 1. Lochia has a ‘has_amount’ relationship with the characterizing concept ‘amount,’ and a ‘has_odor’ relationship with ‘odor’. Data types of these characterizing concepts are coded text; cardinalities for ‘amount’ and ‘odor’ are optional.

Table 1 - Lochia data specification

Characterizing concept	Relationship	Type	Cardinality	Value
Amount	has_amount	Coded text	Optional 0..1	[almost none a little moderate a lot]
Odor	has_odor	Coded text	Optional 0..1	[foul none]
Color	has_color	Coded text	Optional 0..1	[rubra serosa alba]
Subject of information	has_subject_of_information	Coded text	Mandatory 1..1	[patient]

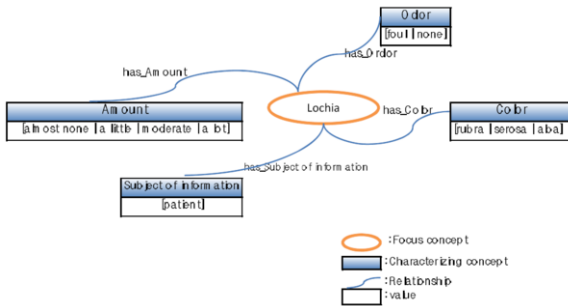


Figure 1- Schematic of lochia data specification

Validation of data specifications

Data specifications were validated by a group of experts, as described above, and tested by applying them to published case reports. Based on the recommendation of one expert, 'greenish' was added to the value set of the characterizing concept 'color' in the data specifications rupture of membranes and abscess. The characterizing concept 'interpretation' was removed from blood sugar, body weight, and pulse data specifications because two experts pointed out an overlap of information between the characterizing concepts 'numerical quantity' and 'interpretation' for the blood sugar, body weight, and pulse data specifications.

With the aid of case reports from the literature, data specifications unique to maternal nursing such as menstruation history, gravida, parity, abortion, Bishop Score, uterine contraction, and rupture of membranes were validated. In this validation, we verified whether the data specifications developed in the study cover data elements in the two case reports. Table 2 indicates how the section describing rupture of membranes was decomposed and mapped to values of characterizing concepts in the rupture of membranes data specification.

In this description, values of characterizing concepts of the data specification rupture of membranes, such as 'interpretation', 'occurrence', 'color', 'instrument', and 'subject of information' were identified. For example, 'M.S. reported a gush of clear fluid at 6:30 p.m.' has information about the time of rupture, the color of the fluid, and the subject associated with the information. All of these values were covered by the value sets of the characterizing concepts of data specification of 'rupture of membranes' developed in this study.

Table 2 - Validation of rupture of membranes data specification using case reports

Description of rupture of membranes in the case report	Extracted value	Characterizing concept
M.S. reported a 'gush of clear fluid' at 6:30 p.m.	Were confirmed (positive)	Interpretation
Ruptured membranes were confirmed by sterile speculum exam.	At 6:30 p.m.	Occurrence
	Clear (none)	Color
	Speculum exam	Instrument
	M.S. (patient)	Subject of information

Discussion

We developed data specifications to model the nursing problems of pregnant women who were hospitalized to give birth. These data specifications were validated by a group of experts and tested by applying them to case reports published in the literature. We identified focus concepts and characterizing concepts by analyzing electronic nursing records, reviewing the literature, and consulting nurse experts. We identified 58 focus concepts. Most of those identified by analyzing electronic nursing records were concepts describing physical problems such as pain, diarrhea, and constipation. Psychosocial concepts such as grief, guilt, and parent role were identified from the literature review and by consulting nurse experts. This implies that nurses do not document the psychosocial problems of their patients in their nursing notes as frequently as they document their physical problems. This concurs with what Min found in her work developing archetypes of nursing problems for breast cancer patients [7].

We found 53 characterizing concepts to describe focus concepts in more detail, of which only 13 were identified through analysis of the electronic nursing records. Most (54%) were identified from a literature review, and the remainder were suggested by the nurse experts. This implies that nurses do not document nursing problems in a structured way or as precisely as found in the literature or recommended by experts.

The data specification of nursing problems can be classified based on the characterizing concepts with value sets. For example, data specifications for flat nipple and inverted nipple have the same characterizing concepts ('anatomical site' and 'subject of information') with the same value sets. Other examples with the same characterizing concepts and the same value sets are the data specifications of constipation and diarrhea. However, there are similar focus concepts with different characterizing concepts. For example, after pain and labor pain are both types of pain, but they have different characterizing concepts from those of the data specification pain. For example, the data specification of pain has a characterizing concept 'anatomical site', whereas the data specifications of after pain and labor pain do not. If two focus concepts have different characterizing concepts and value sets, we classified them as different types of data specification.

Data specifications were modeled by linking the characterizing concepts to the focus concepts and specifying value sets, data types, and cardinalities of the characterizing concepts. There are two different types of relationship between the focus concepts and the characterizing concepts: associated and partitive. An example of an associated relationship is 'has_severity' linking the characterizing concept 'severity' to a focus concept such as pain. An example of a partitive relationship is 'has_part' linking a simple focus concept such as body temperature to a complex focus concept such vital signs.

A list of values for a characterizing concept was identified and presented in the data specification. For example, the characterizing concept 'severity' has a value set of 'mild', 'moderate', and 'severe'. The data type of the characterizing concept was also suggested in the data specification based on the value set. The cardinality of the characterizing concept, which indicates whether a specific characterizing concept is mandatory or optional to describe a focus concept, was also suggested in the data specifications.

The data specifications developed in this study can be used to guide the structured documentation of nursing records. If data are collected in a structured way using data specification, a richer and more granular database will be developed for use in research and education. In addition, if data are collected in a structured way using a value specified in the value set, data can be shared and exchanged between different information systems and different health-care institutions.

The data specifications developed in this study can ensure that electronic medical records contain meaningful and valid information, and support the semantic interoperability of information. The procedures and methods used here to develop data specifications could be expanded to other areas of nursing.

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