Sending Electronic Nursing Discharge Messages Using the HL7 v3 Care Provision Standard

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Abstract. There is a growing need to exchange nursing related information electronically from one health care professional to another, crossing institutional, time and language boarders. Both continuity of care, care for populations, decision support and secondary use of patient data are valid uses of nursing information. Achieving electronic exchange of nursing information requires information analysis, modeling, standardization and deployment in electronic health systems. The HL7 working group 'Patient Care' has developed a set of HL7 v3 messages that allows nursing content to be specified and exchanged between electronic patient record systems, or systems deployed for secondary data use. This contribution discusses the dynamics of the process and the use of electronic messages for continuity of care. Also, the use of nursing terminology and assessment scales within HL7 v3 messages is illustrated. The Care Provision message is useful for sending structured nursing information between health care facilities.

Keywords: electronic patient record, discharge summary, continuity of care, standards, HL7, nursing discharge message

1. Introduction

There is a growing need in nursing to exchange patient discharge information in electronic format, using health informatics standards [1, 2, 3, 4]. Several standards are required to achieve this, and all are now available, implemented, and used in the field of nursing. Goossen [5] identified a typology of five standards required in nursing to achieve semantic interoperability. Semantic interoperability is the electronic exchange of patient data between electronic health record systems (EHRs) in a timely and meaningful manner, such that the receiver understands the data and is able to give appropriate care to the patient.

The five types of standards necessary for electronically exchanging nursing information include [5]:

[1] Clinical standards, supporting evidence based care from which required data elements can be derived,
[2] Terminology standards giving defined meanings to data,
[3] Standardized information modeling, allowing the data to be used in electronic patient record systems and electronic messages,
[4] Process and communication modeling, allowing to exchange information at the right time, and
[5] Technical standards allowing the safe use of information and communication technology in health care.

Traditionally, nursing as profession has invested in terminology standards and dataset specification. In more recent years development and testing of evidence based assessment instruments and interventions has gained interest. In addition, clinical pathways streamline processes for continuity of multidisciplinary care. Developing logical information models however have had limited attention in the profession.

Logical modeling includes the structural component of data elements, their characteristics and relationships, and the dynamic components of data management such as activity diagramming and specification of trigger events, interactions and behaviors of supporting technology. It is however exactly in these areas of structural and dynamic information modeling where valuable and cost effective solutions have been developed [4, 5, 6, 7, 8] and are thus available to nursing. These allow nursing to break with traditional silo applications and facilitate integrating nursing content in health care information systems that are semantically interoperable.

2. Objectives

This paper discusses the development, summary content, and verification of the Health Level Seven Version 3 (HL7 v3) Care Provision electronic messages for referral, discharge, and record querying and exchange. Given existing work in the nursing profession, the use of these messages in nursing require only a specific data format specification, and use case and dynamic model validation, to be implementable as Electronic Nursing Discharge Messages. The 'how to' of electronic messaging in nursing is explained, referring to earlier development and testing work of HL7 v3 Care Provision messages.

3. Materials and Methods

To use existing HL7 v3 message standards appropriately, nursing professionals need to carry out activities to make it work for Electronic Nursing Discharge Messages. These activities include information analysis and modeling, following to some extends the Health Level Seven Development Framework (HDF) [6].

3.1.   Information analysis

a) Identification of the area of interest: what should be in the Electronic Nursing Discharge Message and who are the communication partners? This includes identification of the stakeholders and setting overall objectives for the project. For instance, determine a continuity of care record for stroke patients that facilitates in safely exchanging information from hospital to nursing home.

b) Identify all actors and institutions that contribute in one way or the other to the discharge process. This can be a discharge nurse, an attending physician ordering discharge, an admission nurse in a nursing home, or an independent checking of eligibility.

c) Determine the processes or workflow. Patient care usually takes place in several phases, which need to be described to attain clarity and to determine what the message content per phase must be. For example, a stroke patient typically follows the route via Emergency Department to Stroke Unit to follow up care. Data exchanged include neurological status, Pain, Vitals, Glasgow Coma Scale, Barthel index, and family circumstances.

d) Determine the various communication moments between the caregivers and institutions. Think of transfer, requests for care activities, or handing over responsibility of care. Distinguish here between human communication and the electronic data transfer in the Electronic Nursing Discharge Message.

e) Identify required data elements that nurses need to exchange in the Electronic Nursing Discharge Message. There are repetitive datasets, data sets that are

relevant for each patient category, and datasets that are only relevant for an individual. The first and second categories can be specified as detailed clinical models [9]. This leads to a table overview of data that need to be included in Electronic Nursing Discharge Message.

3.2. Information modeling using Unified Modeling Language

Unified Modeling Language (UML) is an important methodology for information modeling to analyze domains systematically and to develop information and communication technology [10]. In general, the following UML models are relevant for the Electronic Nursing Discharge Message: modeling the dynamics, which include the workflow and the communication sequence, and modeling the static information in the domain into class diagrams. The following results are required:

f) Develop the dynamic model: use cases, storyboards, activity diagrams, and interaction diagrams. The use case tells what the starting situation is, what happens during the process and the message transfer and what the end situation is. The storyboard relates this use case to an example of a real patient. Activity diagrams describe the systematic workflow for all professionals around the discharge. Each phase is written out in detail; who are involved, how does it start, what happens next, what decisions are made and what is the end of a phase?

g) Apply the static modeling. This is done as follows: First approach is to draw up an UML class diagram covering the whole domain. Examples of this include e.g. the perinatology domain [11]. However, given the increased availability of standard EHR or message components such as HL7 templates[6], CEN 13606 [7] / OpenEHR [8] archetypes, or Detailed Clinical Models (DCM)[9], it becomes possible to just 'go shopping for the ingredients' and compile a message very quickly. It is the latter method discussed here further, using the HL7 v3 Care Provision message, which has undergone several years of verification and testing. [5, 6, 11]

h) Map the data elements to the HL7 v3 Care Provision message standard. This can be done for instance in an Excel worksheet, but any table format is doable. Where available, it is possible to map standardized clinical terminology to each data element. In particular, a unique code is mandatory for each single data element. In addition, the correct data type can be determined.[12]

4. Results of modeling work

In the dynamic modeling, the following use cases examples exist for discharge. The first use case is to prepare discharge of the patient. The physician informs the patient and obtains consent for admission to nursing home and electronic exchange of data. Figure 1 illustrates the UML activity diagram for the Electronic Nursing Discharge Message. The 2nd use case is the discharge order. The precondition of this use case is the patient's permission. The activities include the physician ordering the discharge, the discharge nurse pulling up relevant data from the EHR system, and compiling and sending a HL7 v3 Care Provision Referral Message. The post condition is the message sent to Eligibility check, which is the 3rd use case. For example, here it is checked and decided if the patient is eligible for nursing home care. If the patient is eligible for nursing home care, the discharge message and the proof of eligibility are send to the

nursing home, where use case 4 follows. Use case 4 has precondition receiving the message, activities (not shown) include accepting the data from the message to the EHR of the nursing home, carrying out additional admission activities, such as drawing up the care plan for long-term care. The post condition of use case 4 is the start of care delivery in the nursing home. Figure 1 illustrates this in a generic manner, more details can be added for localization.
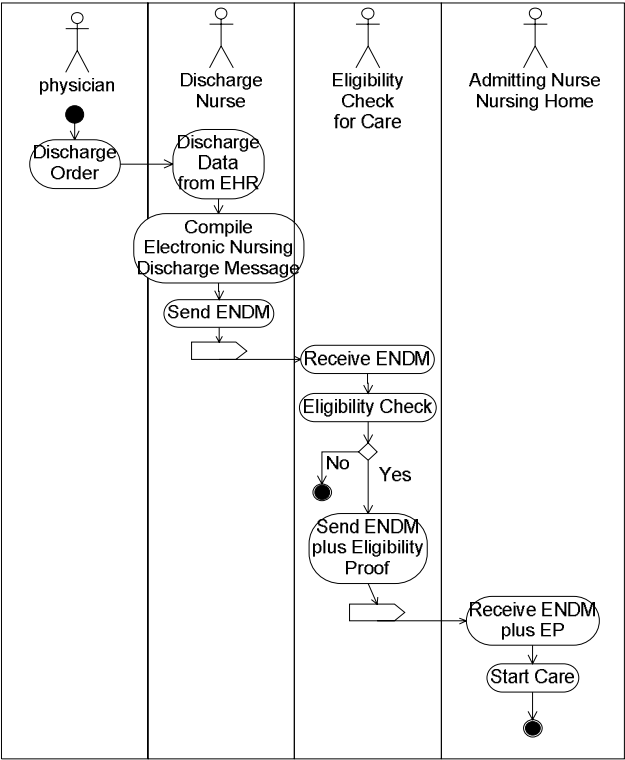

Figure 1: Activity Diagram of Electronic Discharge

Figure 2 illustrates the HL7 v3 Care Provision Message Model. This model was created during intensive user driven verification sessions,[11] and tested in 2 other domains. It is further developed as Draft Standard for Trial use.[6] The DSTU is a formal ANSI standard allowing the test in practice of the standard during several years before finalizing to a full normative standard.
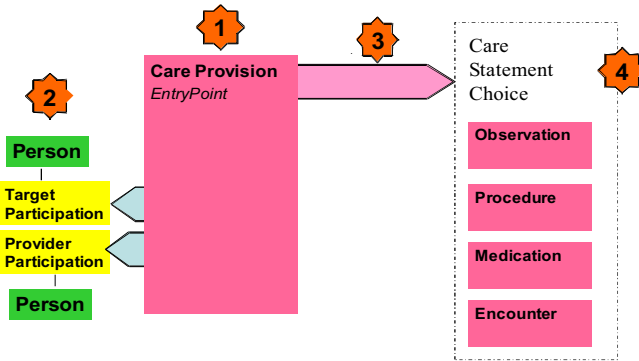
Figure 2: the HL7 v3 Care Provision Message summary (Class attributes such as code, time, value, are not shown).

Figure 2 shows a summary in which (1) is the care provision as period of responsibility for care, (2) illustrates the persons participating in their respective roles of patient and health care provider. In (3) the relationship of individual care statements to the care provision is depicted. The choice box (4) allows including in the HL7 v3 message one to many data items of choice of the provider.

Goossen et al[13] explain in detail the way nursing process in general, and nursing data elements can be included in HL7 v3 messages. This paper focuses on more detail of the actual representation of nursing data items in the Care Provision message. The Care Provision message is developed for continuity of care, including referral, discharge and record exchange. Due to the use of the HL7 v3 choice box model, it is possible to take any desired number of data elements and include this in the HL7 v3 XML message format (eXtended Markup Language). Thus, the reusable structure of the HL7 v3 message including details of sender, receiver, subject and purpose of data exchange remains the same, requiring only one implementation of the message structure and dynamics for thousands of variants that can be send. Any relevant selection of data elements goes in the message structure as a nested XML sub element. This can be repeated for 10, 100 or billions of data elements, provided the EHR allow the data entry into the system and the data extraction from the EHR database into the message. The nurse selects the elements from the EHR, includes these in the message, and sends it to any receiving organization or provider that has an EHR that is again able to extract the data from the message, store it, and present it to the user. Any nursing data element such as signs, observations, nursing diagnoses, nursing interventions, and nursing outcomes are exchanged as care statements in the HL7 v3 message.

Table 1 illustrates how example nursing data elements can be listed, operationalized, mapped to the appropriate HL7 v3 class in the care statement choice box, have class attributes explicit, and are mapped to standardized terminology and to ISO data types.

Table 1. Nursing data elements mapped to HL7 v3 Message, ISO data type and standardized terminology

Nursing Data Element	Operationalization/ method/ value set	HL7 v3 Message and Class	HL7 v3 attributes	ISO/ DIS 21090 Data type	Termi nology	Code for data item
Glasgow Coma Scale (GCS)	Total score sum of three variables	Care Provision Message Observation Class	moodCode code effectiveTime value	CS CD TS PQ	LOINC	9269-2 Glasgow Score Total
E= Eye opening as part of GCS (Motor and Verbal left out on purpose)	4 Spontaneous 3 To speech 2 To pain 1 No response C Not to determine	Care Provision Message Observation Class	moodCode code effectiveTime value	CS CD TS CO	LOINC	9267-6 Glasgow Score Eye Opening
Systolic Blood Pressure	in mmHg	Care Provision Message Observation Class	moodCode code effectiveTime value	CS CD TS PQ	SNOM ED CT	271649006: systolic blood pressure
Diastolic Blood Pressure	in mmHg	Care Provision Message Observation Class	moodCode code effectiveTime value	CS CD TS PQ	SNOM ED CT	271650006: diastolic blood pressure
Pain	nursing diagnoses, focus and judgment collapse	Care Provision Message Observation Class	moodCode code effectiveTime value	CS CD TS CD	ICNP 1.1	Pain: 10023130
teaching about pain	nursing intervention, focus and action	Care Provision Message Procedure Class	moodCode code effectiveTime	CS CD TS	ICNP 1.1	Teaching About Managing Pain 10019489

5. Discussion and Conclusions

This paper highlights the current state-of-the-art of applying the HL7 v3 Care Provision message standard for use in the domain of nursing. Following a process of carefully analyzing and modeling the nursing domain with respect to 5 types of standards, it becomes feasible to quickly develop and implement an Electronic Nursing Discharge

Message. This message standard for which nursing as profession, and in particular the clients they care for, have been waiting for quite a while, is now available for widely use. In addition, specification of nursing data elements according to CEN / ISO and HL7 v3 information modeling, ISO data types, and nursing terminology standards is possible. Testing of the HL7 v3 Care Provision message has been described elsewhere [5, 11]. Testing its use for nursing discharge messages is imperative. Currently, many nursing data elements in such standardized fashion are available in the format of the Detailed Clinical Models.

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