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From Capturing Nursing Knowledge to Retrieval of Data From a Data Warehouse

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Abstract. The purpose of the project was to capture nursing data and knowledge, represent it for use and re-use by retrieval from a data warehouse, which contains both clinical and financial hospital data. Today nurses at LUH use standardized nursing terminologies to document information related to patients and the nursing care in the EHR at all times. Pre-defined order sets for nursing care have been developed using best practice where available and tacit nursing knowledge has been captured and coded with standardized nursing terminologies and made explicit for dissemination in the EHR. All patient-nursing data is permanently stored in a data repository. Core nursing data elements have been selected for transfer and storage in the data warehouse and patient-nursing data are now captured, stored, can be related to other data elements from the warehouse and be retrieved for use and re-use.

Keywords: data warehouse, standardized nursing terminologies, knowledge management, nursing informatics

Introduction

The use of data in the electronic health record (EHR) is a promising step to support patient care, research, quality, outcomes and new discoveries for best practice. The retrieval of patient data is dependent on data being entered into a clinical data repository in an organized way by standardized terminologies. The data then need to be transferred into a data warehouse for long-term storage and retrieval where concepts or variables and their relationships are formally expressed in a structured way for analysis of patient populations. Of concern is, however, that the use of standardized nursing terminologies in patient records worldwide is still lacking[1] and nursing data poorly represented in data warehouses[2]. Of further concern is that data in patient records may not be a reliable source because they lack accuracy, completeness and comprehensiveness[1]. Knowledge within health care has grown almost exponentially over the past years. Knowledge has been categorized in various ways (e.g., as tacit, explicit and organizational). Tacit knowledge resides in the human brain and is the "know-how". A large amount of such knowledge is created through communications

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that may be complicated to codify, translate and apply. Lately, more and more healthcare organizations have acknowledged that nurses represent knowledge asset, but nursing shortage and turnover in nursing leads to a significant loss of tacit knowledge every year[3]. Explicit knowledge refers to the formal knowledge that has been written in documents or databases or codified. An example of that is the development and dissemination of best practice and use of clinical guidelines in patient care which has increased enormously in recent years. Organizational knowledge is embedded in specific principles, standards, policies, procedures, guidelines and processes used in organizations[4]. A huge amount of nursing knowledge has not yet been captured and strong evidence for its effectiveness is still lacking.

1. Background

Iceland is one of the five Nordic countries and has 320.000 inhabitants. The country has long taken pride in its healthcare system, which is based on a national health insurance. Infant mortality is the lowest rate of all OECD (Organisation for Economic Co-operation and Development) nations (1.8 per 1.000) and life expectancy is high at 81.5 years. Iceland also has a good track record in the treatment of chronic illnesses, as reflected in the low mortality rates from cancer, stroke and ischemic heart diseases[5].

Landspítali (LUH), the National University Hospital in Iceland, provides services in all major medical specialties and serves as the country´s only university hospital and referral center. In 2012, LUH had 650 beds, 27.400 admissions, 409.000 ambulatory visits, 14.000 surgical procedures, and 3.300 deliveries. Employees were approximately 4.600 (3.640 full-time equivalents), thereof 1.300 registered nurses and 530 licensed practical nurses[6].

The EHR system, SAGA, has been in development and use at LUH for over 20 years and is now a central part of the hospital‘s modular EHR. More or less all nurses in Iceland are familiar with standardized nursing terminologies (mostly NANDA-I, NIC, NOC, Omaha and lately ICNP) through their nursing education and/or practice. The main functional requirements with respect to documentation of nursing care, has been described elsewhere[7]. Two of the requirements were that „all patient data ... should be reusable and accessible to all healthcare professional involved in the care of the patient, ...and patient data should be accessible for retrieval and analysis for the purpose of quality improvement and administration“[7, p.383].

The purpose of this project was to capture nursing data and knowledge, represent it for use and re-use by retrieval from a data warehouse. The goals of the project were to:

- Implement standardized nursing terminologies for documentation of nursing assessment, diagnoses, and planning of interventions (outcomes are still pending) in the EHR.
- Develop pre-defined order sets for nursing care by a) using best practice where available and b) transforming tacit nursing knowledge into explicit knowledge for use in the EHR
- Structure the format of nursing care plans with standardized nursing terminologies
- Store the captured and standardized patient-nursing data in a data repository

- Define a core nursing data set for transfer into a data warehouse for re-use
- Construct a nursing universe within the data warehouse

2. Material and Methods

Phase 1. Standardized Nursing Documentation and Knowledge Translation
Since 2011 nurses have documented all nursing care at LUH in the EHR system. The nursing process model in the decision making process used in the EHR system for documentation comprises assessment, diagnosis, planning, and evaluation. The nursing assessment is a combination of predefined pop-up lists, check boxes, which are coded and free text. The nursing care plans contain a set of nursing diagnoses and collaborative problems, signs and symptoms, related factors, nursing interventions and related nursing activities. Nursing care plans can be either made from scratch or standardized with a set of pre-defined order sets for nursing care of patients with a specific condition or undergoing a specific procedure as a minimum level of required care. The standardized nursing care plans serve as a grid for the nursing knowledge expressed by the standardized nursing languages (NANDA, NIC and ICNP) and are structured to make preservation of the linkage of the nursing process elements in the data warehouse possible.

Shortly after going life with all nursing documentation electronically in 2011 it became evident that decision support for planning nursing care was not sufficient and not supportive enough for nurses in patient care. The latter half of this phase therefore aimed at revising existing nursing care plans using best practice (explicit knowledge) as well as capturing tacit nursing knowledge. Nurses within each specialty wrote up nursing care plans appropriate for a specific patient groups or patient conditions. Nurses were instructed to refer to, and not repeat, interventions or activities being described elsewhere, such as, in clinical guidelines, work procedures in the Quality Control Manual or check lists in use at the hospital (organizational knowledge). The structure of the care plans was made more unified, and the new care plans were better supported with best evidence than before. All content of the care plans was then coded with NANDA, NIC and/or ICNP. Signs and symptoms, related factors and activities for interventions have been coded as well. The knowledge and best practice were captured and stored in such a format that the content can be disseminated and used again. All standardized nursing care plans were reviewed by nursing specialists for nursing content and by nurse informaticians for format and information structure.

2.1. Phase 2. Construction of a Nursing Universe in the Data Warehouse

Construction of the data warehouse is an ongoing project where data is being transferred from several repositories or systems (Figure 1), such as, clinical data from the EHR, hospital information, medication management, laboratory, and financial systems. Clinical data is permanently stored and available for retrieval on e.g. patient demographics, medications (ATC), detailed surgical data, waiting lists, birth registry, adverse events (patients and staff), DRG, detailed cost data, lab tests (in development clinical chemistry, hematology, immunology, bacteriology, virology, clinical genetics), ICD-10 diagnoses, surgical procedures (NCSP), nursing data from a patient

classification system (since 2011) (staffing, patient acuity, work load in RAFAELA), data from on-site clinical nursing documentation in the EHR e.g. nursing diagnoses (NANDA-I and ICNP) and nursing interventions (NIC and ICNP), signs and symptoms, and vital signs.

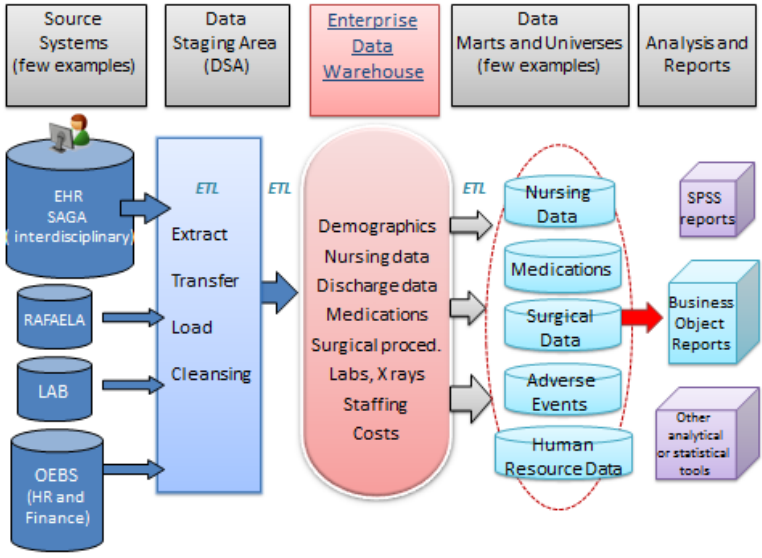

Figure 1. Overview of the data warehouse at Landspitali University Hospital

Phase 2 focused on selecting the core nursing data to be transferred from the EHR repository into the data warehouse. A priority was to define and analyze data items that reflected patients' conditions and performed nursing care and how these items should be related in the data warehouse for storage and later retrieval. This was done by nurses specialized in nursing informatics. In the first round the core data were: a) items related to nursing assessment, e.g. on self-care, activity, sleep, role and relationships, risk for falls and pressure ulcers, nutritional status, pain, symptom assessment; b) nursing diagnoses, signs and symptoms, related factors and nursing interventions; c) discharge data, e.g. resource use and referrals; and d) other, e.g. invasive devices, allergies. A part of this last phase was to pilot test the data elements within the nursing universe by testing the relationships between the elements (e.g. if nursing interventions by a nursing diagnosis were correctly related) and if the data elements within the nursing universe could be related to data elements in other universes (e.g. nursing interventions by a nursing diagnosis in a ward or a certain patient population or ICD-10 diagnoses). In Figures 2 and 3 is an example of the question of how many patients had the nursing diagnosis acute pain and what nursing interventions were used.

2.2. Phase 3. Improvement of Nursing Data in the EHR

Several means have been developed in the hospital to improve the quality of the nursing data and increase nurses' awareness of its importance. Several educational sessions have been offered, such as, on the importance of documenting nursing care

and that nursing data need to reflect the present condition of patients, the nursing process, standardized nursing terminologies, and how to use the EHR. Nurses can earn continuing education credits for staff development by attending some of the educational sessions. Short teaching videos are available on-line, e-mail/ telephone support and consultation is offered. Also a clinical or quality dashboard is being developed at LUH to display meaningful data or safety indicators, such as, patients at risk for falls, pressure ulcers or with poor nutritional status. Information on the dashboard is also intended to increase nurses' awareness of the ward's performance in documentation related to nursing care and thereby the quality of the data.

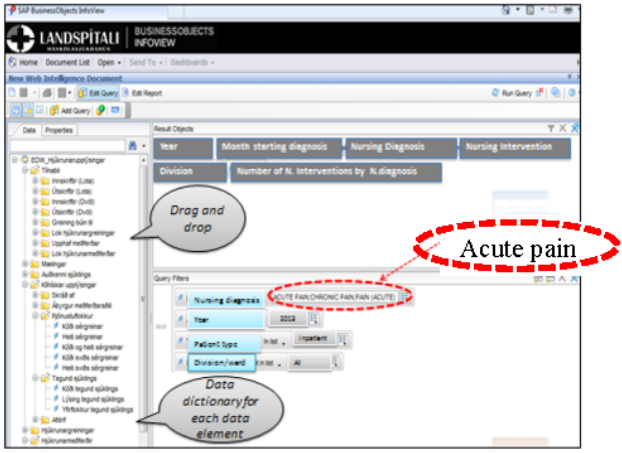

Figure 2. An example of the data dictionary and how to retrieve data elements by dragging and dropping to make reports.

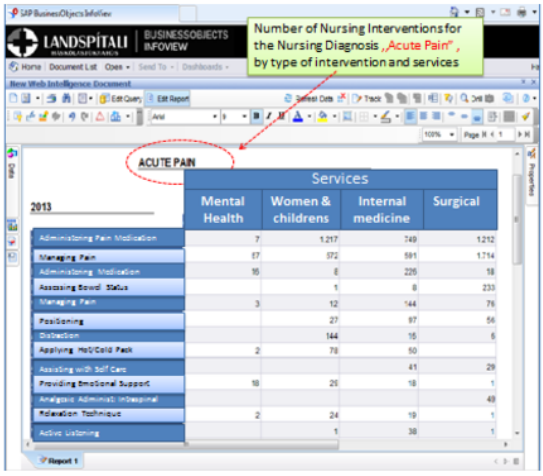

Figure 3. A report example of nursing interventions in various in-patient services are shown for the nursing diagnosis Acute pain.

Another mean to improve nursing data was to revise the hospital policy with detailed criteria or parameters regarding nursing documentation. The defined parameters for documentation are now being used to develop feedback reports which are sent to nurse managers to inform them on their nursing staff performance related to nursing documentation. Data for the reports are retrieved from the EHR data repository. An example could be, if nursing assessment has been done on all admitted patients in a timely manner, or if care has been planned and documented for all diagnosed nursing problems. These parameters will also be shown on the clinical dashboard.

3. Outcomes and Present State

Based on the goals for this project nurses at LUH at all times use standardized nursing terminologies to document information related to patients and the nursing care in the EHR. Pre-defined order sets for nursing care have been developed using best practice where available and tacit nursing knowledge has been captured and coded with standardized nursing terminologies and made explicit for dissemination for use in the EHR. All patient-nursing data is permanently stored in a data repository. Core nursing data elements have been selected for transfer and storage in the data warehouse and patient-nursing data are now captured, stored, can be related to other data elements and be retrieved for use and re-use for nursing research, quality control and management. The construction of the nursing universe was done on the terms of nursing, which is very important for future use. Along with good training in using the data warehouse reports the definitions for each element must be very visible for the user. Today we are testing the data for nursing diagnoses and interventions and tailoring pilot reports for nurses and nurse managers for future use using business intelligence software.

4. Discussion

Knowledge management depends on organizational structure, technology and culture to improve the flow of knowledge and its use in clinical practice. In addition to this, sufficient time and financial resources are also needed. The project presented here was a huge undertaking which involved a large number of nursing staff at the hospital at all levels (e.g. staff nurses, nurse managers, chief nursing officer) as well as other health care workers and computer scientists. The organizational structure was for the most part in place and will not be dwelled on here. A consensus on software changes or development that needed to be done was rather easily reached and even it took long time it was delivered, but past due time. Once the core data to be transferred into the data warehouse had been decided on and the important relationships in the database defined construction of the nursing universe was divided into smaller steps. Not all the steps have been completed yet but the complexity of this part of the project turned out to be rather simple, compared to Phase 1 of the overall project, but long lasting.

Phase 1 (capturing and coding nursing knowledge) was by far the most difficult, and most time and energy consuming and culturally difficult. To codify best practice and tacit knowledge represented in standardized nursing care plans was a complicated task for many reasons. Nurses' knowledge of the standardized nursing terminologies

was not as deep as we had anticipated, and we probably overestimated nurses' ability to translate best practice into clinical practice with standardized nursing language. To capture and unify tacit, explicit and organizational knowledge in a structured format was therefore a lot of work. Tacit knowledge in nursing was captured and translated into clinical data and the relevant data associated with the condition of individual patients. The clinical data is stored and can now be aggregated across hospital patient populations for research, quality control and management. The translated care plans have become an important knowledge resource that can contribute to patient safety, quality of care and later to clinical decision support with further development of nursing informatics.

A lot of the knowledge used by nurses at LUH to plan and perform nursing care is often based on experience rather than best evidence. In many instances research is lacking in nursing and many nursing interventions need to be tested for effectiveness. Nursing data is now well represented, linkages of the nursing process elements in data warehouse are preserved and available for extraction in the data warehouse and gradually a big database will be built up. This will open up opportunities for using big nursing data sets for research and the next steps are to start using the data to answer specific questions. Of concern is, however, that earlier studies performed in the hospital show that when documented care was studied, best available knowledge was not always used for planning patient care, e.g. for patients with identified pressure ulcers and that data was frequently missing on patients' conditions and performed care[8]. When data from any of the nursing process elements are missing, data in the EHR and the databases may not be a reliable source because they lack accuracy, completeness and comprehensiveness and data for research and decision support become deficient, a circumstance that could seriously hamper patient safety, research and generation of new knowledge, and impair quality of care. Improvement of nursing data quality will therefore be an ongoing project before the data is ready for secondary data use.

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