Development Eletronic Systems of Nursing Clinical Documentation structured by diagnosis, outcomes and interventions

DESENVOLVIMENTO DE SISTEMA ELETRÔNICO DE DOCUMENTAÇÃO CLÍNICA DE ENFERMAGEM ESTRUTURADO EM DIAGNÓSTICOS, RESULTADOS E INTERVENÇÕES

DESARROLLO DEL SISTEMA ELETRÓNICO DE LA DOCUMENTACIÓN CLÍNICA DE ENFERMERIA ESTRUCTURADO EN DIAGNÓSTICOS, RESULTADOS E INTERVENCIONES

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ABSTRACT

Electronic nursing documentation constitutes technical, scientific, legal and ethical documents. This paper reports a study to develop an electronic nursing documentation system. The system was developed in four phases (conceptualizing, detailing, prototype building and implementation), and the knowledge base was based on domains and classes according to the NANDA-I, NIC, and NOC unified framework. The result was an electronic system (PROCEnf-USP - Nursing Process Electronic Documentation System of the University of São Paulo) for electronic nursing process documentation and reports, including a functionality to support decisions on nursing diagnosis, expected outcomes, and interventions. The factors of success of this technological project included integrating varied fields of knowledge, as also as the institutional feature of valuing the continuous theoretical and practical improvement of the nursing process.

KEY WORDS

Nursing informatics.
Medical Records Systems, Computerized.
Nursing diagnosis.

RESUMO

A documentação eletrônica de enfermagem constitui documentos técnicos, científicos, legais e éticos de saúde. Este artigo é o relato de estudo de desenvolvimento de um sistema de documentação eletrônica de enfermagem. O sistema foi desenvolvido em 4 fases (conceituação, detalhamento, elaboração de protótipo e implantação) e a base de conhecimento foi organizada em hierarquia de domínios e classes, segundo a estrutura unificada das classificações NANDA-I, NIC e NOC. O resultado foi o desenvolvimento do sistema eletrônico PROCEnf-USP (Sistema de Documentação Eletrônica do Processo de Enfermagem da Universidade de São Paulo) que permite a documentação clínica e a geração de relatórios do processo de enfermagem, além de fornecer apoio às decisões sobre diagnósticos, resultados esperados e intervenções de enfermagem. Os fatores de êxito desse projeto de produção tecnológica compreenderam a articulação de diferentes áreas de conhecimento, bem como a valorização do contínuo aprimoramento teórico-prático do processo de enfermagem da instituição.

DESCRITORES

Informática em enfermagem.
Sistemas Computadorizados de Registros Médicos.
Diagnóstico de enfermagem.

RESUMEN

La documentación electrónica de enfermería produce documentos técnicos, científicos, jurídicos y éticos de salud. El objetivo diste articulo es relatar lo desarrollo de un sistema de documentación electrónica para la enfermería. El sistema fue desarrollado en 4 etapas (conceptualización, detalles, creación de prototipo y implantación) y la base de conocimientos fue organizada en jerarquía de dominios y clases, según la estructura unificada de las clasificaciones de la NANDA-I, NIC y la NOC. El sistema PROCEnf-USP (Sistema de Documentación Electrónica del Processo de Enfermería de la Universidad de São Paulo) desarrollado permite la documentación clínica y la producción de reportos del proceso de enfermería, bien como apoya las decisiones sobre los diagnósticos, resultados esperados y intervenciones de enfermería. Los factores de éxito del proyecto de producción tecnológica comprenderán la integración de diferentes campos del conocimiento y la valoración del continuo desarrollo teórico-práctico del proceso de enfermería de la institución.

DESCRIPTORES

Informatica aplicada a la enfermería.
Sistemas de Historias Clínicas Informatizadas.
Diagnóstico de enfermería.

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INTRODUCTION

The nursing process (NP) directs a style of thinking, in a questions-answers-questions continuum within dynamic context, with a view to making appropriate decisions about patients' care needs (diagnoses), about what results one wants to achieve (outcomes) and about the best care to see to those needs related to specific desirable outcomes (interventions)[1].

Used in teaching and health services, the NP was called *Nursing Care Systemization* (NCS) in Brazil and ended up being recognized by that name, although the exact reason for this designation is unknown. In this text, 'NP' and 'NCS' will be used with the same meaning.

Reports are frequent about little time to 'do the NP' or about nurses feeling under pressure to 'do the NP'[2-3]. In fact, however, it is the activity of registering the NP documentation, which is undoubtedly an essential nursing activity and takes up a considerable amount of time and energy, which could be spent on patient care.

Nursing documentation, which comprises technical, scientific, legal and ethical documents and provides health institutions with important records for the sake of billing, supports the auditing of nursing actions and, mainly, permits estimating the quality of patient care[5]. Besides consuming quite a lot of time and energy, however, nursing documentation also entails problems in terms of accuracy and relevance and is little used to assess care delivery. One of the reasons for difficulties to use nursing documentation for care assessment purposes can be the lack of clarity about what information needs to be documented in order to truly constitute a base for care quality development programs[6].

The association of three elements has been focused on to improve nursing documentation: the definition of essential data to be included in the records of each care meeting[7-8], internationally known as Nursing Minimum Data Set (NMDS), the use of standardized language systems (or classification systems)[9-10] and computerization[11].

The establishment of essential data - NMDS[8,12] aims to define the set of elements to be documented in nursing care situations. The NMDS includes three data categories: the place or service where the care is delivered; the patient or client and the nursing care itself. The nursing care data category includes nursing diagnoses, interventions and outcomes.

Classification systems, such as NANDA-International (NANDA- I)[13], the Nursing Interventions Classification (NIC)[14] and the Nursing Outcomes Classification (NOC)[15] are instruments to improve the reliability, validity and usability of nursing documentation. Especially if used in well-projected computerized documentation systems, they permit the consistent use of nursing care data to assess nursing care and inform clinical, management and political decisions.

In the attempt to integrate classifications, the alliance between NANDA-I and the Center of Classification and Nursing Effectiveness proposed a structure called NNN (NANDA, NIC and NOC), which establishes a set of four domains and twenty-eight classes to organize the NANDA-I[13] diagnoses, the NIC[14] interventions and the NOC[15] outcomes. Putting the NNN structure in practice in an electronic nursing system improves documentation, encourages nurses to adopt the NP and improves diagnostic accuracy and the achievement of patient outcomes[16-17].

When nursing information is systematically organized and documented through electronic systems, this permits communication, facilitating individualized solving of patients' problems, expressing nurses' technical-scientific and human knowledge and also expanding the visibility of nursing knowledge towards the patient and the multiprofessional team[18].

Computerized systems should go beyond merely transferring documentation from paper to the computer, and also beyond *checklists* of diagnoses and prescriptions, so as to emphasize nurses' decision making and clinical judgment in patient care, with a view to broadening and supporting nurses' clinical decision making.

Computerized systems should go beyond merely transferring documentation from paper to the computer, and also beyond "checklists" of diagnoses and prescriptions, so as to emphasize nurses' decision making and clinical judgment in patient care, with a view to broadening and supporting nurses' clinical decision making. Decision Support Systems (DSS), which use knowledge bases (facts and/or rules) projected to help health professionals in the clinical decision making process, have strong potential to help nurses to deal with the volume of data and the necessary information[19].

Since its creation, the Nursing Department (DE) at the University Hospital of the University of São Paulo (HU-USP) has applied the NP in care practice. Aware of advances in health system information technologies and of the importance of guaranteeing nursing's preparation, not only to register in electronic systems, but also to actually participate in technological development, the DE included the computerization of clinical nursing documentation into its goals. Since 2000, the computerization of clinical nursing documentation was the central concern in the implementation process of the nursing diagnosis and nurses were sensitized to the need to plan processes, so as to support the changes needed with a view to computerizing nursing documentation[1]. In 2003, articulating faculty from the Professional Orientation (ENO) and Medical-Surgical Nursing (ENC) Departments at USP School of Nursing (EEUSP), the project received financial support from the Brazilian Scientific and Technological Development Council (CNPq), which

made it possible to expand the construction project of a DSS for nursing documentation.

OBJECTIVE

To develop an electronic system for nursing documentation, involving a clinical and surgical patient data survey as well as the definition of nursing diagnosis, expected outcomes and proposed interventions.

METHOD

This methodological technological production research took the form of a case study. To develop the system, four cyclical phases were adopted in the creation and assessment of the technological product: Inception, Elaboration, Construction, Transition adopting a project management model based on the Project Management Institute (PMI)[1], with sets forth a set of project management guidelines, orientations and practices that is adopted as a software engineering standard.

Hence, a set of best software development practice principles were adopted, starting from adaptations of the set of processes related to the RUP (Rational Unified Process)[19].

In the Inception phase, the scope of the project is approved and defined, the resources needed for its execution are estimated and expected problems and benefits are identified. In the Elaboration phase, the goal is to analyze the problem domain, in the attempt to complement the survey of usage case documentation. This phase includes system data modeling, that is, when the system is actually programmed. The Construction phase represents system development itself, with a view to refining the requisites, building and testing its components. In this phase, functional prototypes of the system can be used. The Transition phase covers the introduction of the new information system in all environments, user training for usage, integration with other information systems and assessment of user satisfaction[19].

The project presented a data modeling that permits the electronic documentation of patients' assessment data for adult patients hospitalized at the Medical Clinical (CM) and Surgical Clinical (ClC) Units of HU-USP. These pilot units were chosen due to the future easy replication of the obtained results in other hospitalization Units.

To develop the project, a multiprofessional workgroup was set up, including faculty members and baccalaureate nurses, researchers from varied knowledge areas related to clinical care, care process management and health informatics, as well as baccalaureate and graduate nursing students. This permitted a broad view of the project dimensions and the incorporation of specific technological advances from each knowledge area.

The system development Management Group itself comprised the Director of the DE, the Director of the Clinical Nursing Division (DECLI), the nurse from the Educational Support Service, two faculty members and two nurses representing the two units involved. In the detailing phase for data modeling and system development, the HU-USP hired a company that had already developed other systems for the Institution and the DE indicated the Director of the Clinical Nursing Division to be responsible for presenting and negotiating on the Management Group's decisions with the hired company and with the Informatics Sector at the HU-USP. Use cases were validated and the system was approved during meetings between the Management Group, technicians from the hired company and a representative from the HU-USP Informatics Sector.

As other DE areas are expected to put the documentation system in practice, articulation was sought with the Directors and representatives from the Maternal-Infant and External Patient Nursing Division, with a view to their collaboration in the organization of materials for the databases.

Activity timetables were agreed upon between the Management Group and the DE Director, with a view to follow-up of the computerization project and joint work for the creation of the knowledge bases needed to operate the system.

The NANDA-I classification had been put in practice in all HU-USP units since 2005. The nurses developed manual instruments to document the diagnoses, nurses' orders and progress notes[1], which outlined the construction of the system. Approval for the research project was obtained from the Institution's Research Ethics Committee (CEP), registered under Protocol No 590/05.

RESULTS

The *PROCEnf-USP (Nursing Process Electronic Documentation System of the University of São Paulo)* allows users, whether these are nurses or students, to make clinical decisions, supporting diagnostic judgments, expected outcomes and nursing interventions. Users can choose two different routes, depending on their need, and can either enter the clinical assessment data and visualize the nursing diagnosis hypotheses generated by the system or directly choose the nursing diagnoses.

The phases users have to go through follow clinical reasoning, ranging from interview and physical exam data documentation until the nurses' orders documentation. To plan care and document data, users need to follow the PROCEnf - USP phases detailed next:

1. ASSESSMENT: To start documenting the assessment, users have to enter the real (in the professional environment) or fictitious (in the academic environment) patient's registration number. When the patient's data appear, they click on the option **Hide/Show,** select the type of assessment (**Admission**) and click on **Include**. Next, they fill out the date / start time, date / end time, choose the Clinic (E.g.: Medical Clinic, Surgical Clinic), category (E.g. Male Adult, Female Adult) and the type of assessment (E.g.: admission) (Figure 1).

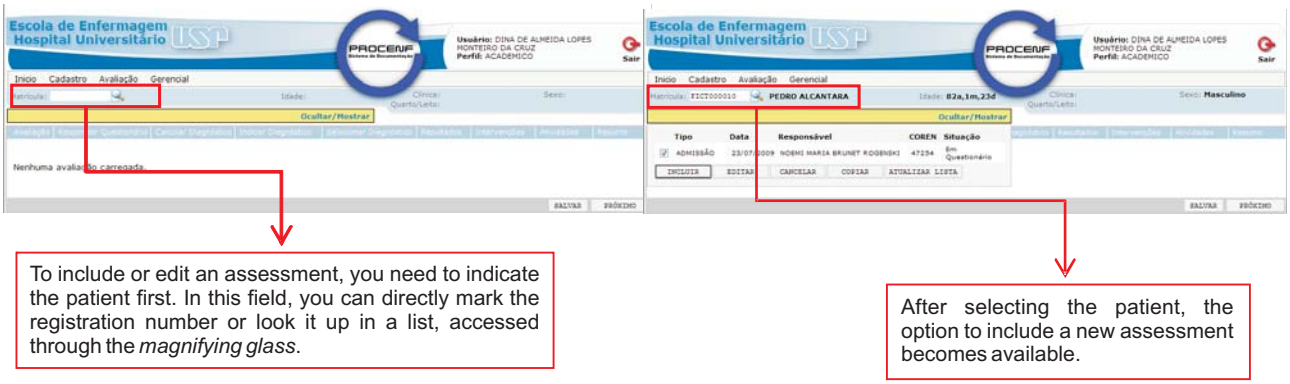

Figure 1: Initial screens of *PROCEnf-USP*- São Paulo - 2009

2. ANSWER QUESTIONNAIRE: users should answer three obligatory General Questionnaires about social and demographic data, health events and the patient's vital signs and, if wanted, can answer other Questionnaires, structured according to the NNN classes, they consider pertinent. When finishing each Questionnaire, users should click on **SAVE.** The answers given to the Questionnaires will automatically generate Nursing Diagnosis hypotheses.

3. CALCULATE DIAGNOSIS: on screen, the system will display all hypothetic Diagnoses, allowing users to see the Defining Characteristics, Related Factor of Risk Factors that were generated based on the answers registered on the assessment questionnaires.

4. INDICATE DIAGNOSIS: users can add other Nursing Diagnoses than those the System put forward. On this screen, they can consult activated Nursing Diagnoses' definitions and add Defining Characteristics, Related Factors or Risk Factors.

5. SELECT DIAGNOSIS: users are responsible for choosing the most accurate diagnosis for patient care. When choosing one or more of these Diagnoses, users should complete documentation on the Defining Characteristics and Related or Risk Factors the patient presents.

6. OUTCOMES: after choosing the Nursing Diagnosis(es), the system will indicate the corresponding possible Outcomes and users need to select the Outcome that best represents what targets should be set for the patient care plan. Users should obligatorily choose at least one Outcome for each Diagnosis. If not, they will not be able to move on in the system. The system permits including other Outcomes besides automatic suggestions.

7. INTERVENTIONS: in view of the chosen Nursing Outcomes, the system will indicate possible Interventions related to the Outcomes. Users have to choose at least one Intervention for each Outcome. If not, they will not be able to move on in the system. The system permits the inclusion of other Interventions besides those indicated.

8. ACTIVITIES: the system presents a set of nursing activities for each Intervention users have chosen. It allows users to include other Activities not linked with the selected Intervention. Additional information can be added to an activity, such as *frequency* and *application sites* for example. Users can indicate the patient's body site the activity refers to, using an iconographic scheme corresponding to the body regions.

9. SUMMARY: The system summarizes the user's assessment, including the following data: evaluator, approver (nurse accredited at the institution), Questionnaires, Diagnoses and respective Outcomes and Nursing Interventions.

10. REPORTS: Users can request the following Reports: *Assessment* (Diagnoses, Outcomes and Nursing Interventions) *Daily Activities* (Diagnoses, Defining Characteristics and Related or Risk Factor, Nursing Prescription) and *Questionnaires* (General: social and demographic data, health events and vital signs; Domain/Class: Answers related to the 28 Questionnaires).

DISCUSSION

The *PROCEnf-USP (Nursing Process Electronic Documentation System of the University of São Paulo)* was developed in line with the four previously established phases.

The *Inception phase* focused on the system and involved the establishment of basic requisites. Therefore, the Clinical Nursing and Nursing Management Minimum Data Sets were surveyed and questionnaires were elaborated to collect Nursing Diagnosis data for clinical and surgical patients[1].

The clinical assessment documentation structure was organized according to a knowledge base, supported by the definitions of the diagnoses and their components, following the taxonomy of domains, classes and diagnoses proposed by the unification of the NANDA-I, NIC and NOC structures[20]. This knowledge base should serve as a documentation guide, capable of generating a list of the most probable nursing diagnoses according to the assessment data documented in the system. For this purpose, the automatic method adopted for recording the patient's nursing assessment was the development of a *branched questionnaire*, in which nurses are led to different questions that can be *customized* for each patient[1].

The *PROCEnf-USP* guides nurses to answer a set of questions whose answers can be tabulated, leading to a probable set of diagnoses and supporting the generation of diagnostic hypotheses. The assessment, analysis and choice of the defining characteristics and applicable related and risk factors, structured in the database of probable diagnoses, allows nurses to decide on what set of diagnoses best pictures the patient's situation at the time of hospitalization, according to their clinical judgment. In this phase, hypotheses are tested and finally, the best diagnosis in the diagnostic process is chosen.

The Management Group developed the branched questionnaire, elaborating questions based on the definitions, defining characteristics and related/risk factors for each diagnosis, and also related to the patient, Braden and pain classification scales. For each class in the unified NANDA-I, NIC and NOC[20] structure, questions were created about related aspects, offering possible answers that would include at least a *clue* to all diagnoses from that specific class. Besides the questionnaires for the 28 NNN structure classes, three further questionnaires were created, which are obligatory when a patient is admitted (social and demographic data, health events and vital signs). The NMDS and previously established institutional protocols guided the definition of these contents, in addition to the NNN structure. Once documented, data from these three additional questionnaires that are relevant for any NNN class are automatically copied to the class(es) they belong to. With regard to the scales, the system automatically calculates the scores and establishes hypotheses on the relevant diagnoses.

The Nursing Management Group defined the link between the answers and the diagnoses by consensus, based on the NANDA-I[13] taxonomy, the theoretical framework from the reference areas and the nurses' clinical experience.

The rule was adopted that it was necessary that all diagnoses could show up in the hypotheses at least once as a result of the answers given to the included questions. Hence, after the (full or partial) data documentation, the system itself presents that diagnostic hypotheses that were automatically generated (calculated diagnoses), which nurses have to confirm or reject, guaranteeing that they take the final decision about the determination of the diagnosis.

Whenever pertinent, questions with the same wording and the same possible answers were repeated in more than one questionnaire (class), as recursive questions. Once documented in one class, those recursive questions are automatically documented in the other class(es) they are present in. This avoids duplicating efforts without violating the structure defined to organize the questionnaires.

To support the choice of outcomes and nursing interventions, the possible connections between diagnoses and expected outcomes and between outcomes and interventions that are pertinent to the HU-USP's context were inserted in the system. Therefore, 66 nursing diagnoses were identified as the most frequent in the Institution's care reality; for each of these diagnoses, possible and desirable outcomes were chosen considering typical patients of HU-USP areas; for each outcome/diagnosis, interventions and activities were chosen, also pertinent to HU-USP practices. Diagnoses, outcomes and interventions were linked, thus integrating NANDA-I[13], NOC[15] and NIC[14] classifications. The diagnoses and expected outcomes were included in the links according to their titles and the interventions were linked according to the activities recommended by the NIC. Links were based on available literature and on reflections about clinical nursing practice at the Institution.

In the **Elaboration phase**, the software was selected that would be used to develop the system. Also, the Use Cases were described, as well as the system interface and the conceptual, logical and physical data modeling. These descriptions were developed based on the information surveyed in the previous phases, adopting paradigms of usability and good user/system relation quality. System specification documents followed current HU-USP standards, which use a subset of the UML *(*Unified Modeling Language*)*.

The information system project demands the use of a database characterized as data warehousing and organization structures, arranged in a predetermined order in function of the system project, with a view to data reorganization and production of defined information[21]. A database is usually maintained and accessed by means of a software known as a Database Management System (DBMS), which offers an interface that allows clients to include, alter or consult data, characterized as the administrative mode. Oracle® was chosen as the database because this tool is used at HU-USP. This base offers an interface so that clients can include, alter or consult data, using a specific programming language: PL/SQL (Procedural Language/Structured Query Language). The relational data warehousing model was adopted, structured as tables, which permit relations between data.

To establish the system's web interface, the .NET platform was used, which is a Microsoft® internet development framework. A framework is a set of methods, standards and classes that define and offer system development resources.

System specifications relate to the following administrative functionalities: a) Integration with other components of the HU-USP Electronic Patient File: One single identification of patients and the health care they receive through their registration in the National Health Register (CNS); b) Systems unification through the Corporate Database; c) Creation of clinical information registration interfaces (*questionnaires*) which users can customize on the fly; d) Preparation for digital signature; e) Information quality insurance, as only nurses registered at the Regional Nursing Council (COREN) are authorized to approve the indication of Nursing Diagnoses, Interventions and Outcomes, in accordance with the law that regulates professional nursing practice; f)Administrative Profile, including a dynamic and flexible presentation of the Questionnaire Register, where nurses can register the clini-

cal assessment, domain and class questionnaires, relating them with the Nursing Diagnoses, Outcomes and Interventions. The questionnaires can be inserted and maintained independently of the Institution's informatics sector; g) Functional Profile, addressing the professional and educational profile, with a view to integration between the HU-USP and EEUSP. The professional environment will be used to document clinical assessment data for real patients. The educational environment permits simulating teaching situations in an on-line learning environment, with the same characteristics as real clinical documentation, where nurses, students and faculty register fictitious patients and simulate decisions on diagnoses, interventions and outcomes. Creating fictitious patients impedes the identification of HU-USP patients for teaching purposes outside the hospital. This procedure is needed for students' learning and to preserve the non-violation of recommended ethical elements.

In the **Construction phase**, a preliminary version (functional prototype) of the system was developed, with a view to surveying the functions and business rules and determining their behavior, thus facilitating the visualization of restriction and system validation. In this phase, meetings were held to validate system functions and business rules. The Management Group responsible for the project approved the result of the construction phase. The electronic nursing data documentation system was called *PROCEnf-USP (Nursing Process Electronic Documentation System of the University of São Paulo)*.

In the **Transition phase**, the system entered a test environment, where several versions were elaborated, until the Management Group approved it to start production. In that phase, the system was installed on the HU-USP server, users received their login and password and user satisfaction was identified.

The nurses manifested favorable opinions about the implementation of the system at the pilot units, adopting a realistic and mature attitude towards the change process.

CONCLUSIONS

Nurses are exclusively responsible for determining what nursing data are essential for electronic health records, as well as the terminologies used to transmit these data. To increase the visibility of nursing, information representing the body of nursing knowledge should be considered. Nurses should awake to the importance of information management with a view to their effective participation in information and informatics policies at the level of central planning entities, such as the Brazilian Ministry of Health for example.

The following success factors stand out in the technological production of the *PROCEnf-USP*: institutional characteristics; support from the Superintendence at HU-USP; consent from DE and effective participation in the project and in developing actions to raise nurses' awareness about the computerization of clinical nursing documentation, as well as the continuous theoretical-practical improvement of the NP since the institution's inauguration. Moreover, the integration between faculty and care staff between EEUSP and HU-USP and articulation among researchers from different knowledge areas is highlighted, which permitted broadening the project's dimensions and incorporating specific technological advances from each knowledge area.

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