

Software for systematization of nursing care in medical units

Software para Sistematização da Assistência de Enfermagem em unidade de internação hospitalar

Software para sistematización de la Atención de Enfermería en unidad de internación hospitalaria

Manoel Gomes da Silva Junior^I, Eliete da Cunha Araújo^I,
Carlos Ramon Silva Moraes^{II}, Lucia Hisako Takase Gonçalves^I

^I Universidade Federal do Pará. Belém, Pará, Brazil.

^{II} VYSCOND Company. Belém, Pará, Brazil.

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RESUMO

Objetivo: Descrever o desenvolvimento de um *software* protótipo para aplicar o Processo de Enfermagem em unidades de clínica médica de um hospital geral e avaliar sua utilidade. **Método:** Pesquisa metodológica aplicada de produção tecnológica de um *software*, baseada na engenharia de *software* de prototipação, desenvolvida em três fases: especificação, desenvolvimento e validação. **Resultado:** Produzido com a denominação de INFOSAE, o sistema representa um conjunto de etapas (Histórico, Diagnóstico, Resultados esperados e Intervenção de enfermagem) que fornece orientação aos enfermeiros para direcionar e garantir a assistência necessária ao paciente, possibilitando ainda avaliar essa assistência. **Conclusão:** O *software* protótipo INFOSAE, tecnologia informatizada de fácil aplicação, teve avaliação favorável dos enfermeiros usuários que participaram de todo o processo de desenvolvimento, desde a especificação até a validação do sistema.

Descritores: Informática em Enfermagem; Processo de Enfermagem; Software; Avaliação em Enfermagem; Planejamento de Assistência ao Paciente.

ABSTRACT

Objective: To describe the development of a software prototype to apply the nursing process in clinical units of a general hospital, and assess its usefulness. **Method:** Applied methodological research of technological production of a program based on prototyping software engineering developed in three stages: specification, development, and validation. **Results:** Produced under the name of INFOSAE, the system represents a set of stages (history, diagnosis, expected outcomes, and nursing intervention) providing guidance to nurses to direct and guarantee the necessary care to patients, also allowing an assessment of this care. **Conclusion:** The INFOSAE software prototype, an easy-to-use computerized technology, obtained a favorable assessment by the user nurses that participated in the whole development process, from the specification to the validation of the system.

Descriptors: Nursing Informatics; Nursing Process; Software; Nursing Assessment; Patient Care Planning.

RESUMEN

Objetivo: Describir el desarrollo de un *software* prototipo para aplicar el Proceso de Enfermería en unidades de clínica médica de un hospital general y evaluar su utilidad. **Método:** Investigación metodológica aplicada de producción tecnológica de un *software*, basada en la ingeniería de software piloto, desarrollada en tres fases: especificación, desarrollo y validación. **Resultado:** Programado bajo la denominación de INFOSAE, el sistema representa un conjunto de etapas (Histórico, Diagnóstico, Resultados esperados e Intervención de enfermería), que brinda orientación a los enfermeros para dirigir y garantizar la atención necesaria al paciente, permitiendo también evaluar dicha atención. **Conclusión:** El *software* prototipo INFOSAE, tecnología informática de fácil aplicación, contó con evaluación favorable por parte de los enfermeros usuarios que participaron de todo el proceso de desarrollo, desde la especificación hasta la validación del sistema.

Descriptores: Informática Aplicada a la Enfermería; Proceso de Enfermería; Programas Informáticos; Evaluación en Enfermería; Planificación de Atención al Paciente.

CORRESPONDING AUTHOR Manoel Gomes da Silva Junior E-mail: manogomes29@gmail.com

INTRODUCTION

A pioneer in the country in the implementation of the computerized nursing process (NP), the nursing staff of the Clinical Hospital of Porto Alegre (HCPA) of the Federal University of Rio Grande do Sul (UFRGS) has been using it since 2000⁽¹⁾, adopting in its software the desktop platform. The University Hospital of São Paulo (HU-USP) also developed and implemented a program called Electronic Documentation System of the Nursing Process of the University of São Paulo (PROCEnf-USP) in 2005⁽²⁾, adopting the same platform. This software aims at enabling nurses to make clinical decisions supported by diagnostic judgment, expected outcomes, and nursing interventions. Both health institutions, admittedly important in the country, found their *modus operandi* in the conception of the system and adequacy of the structure to their own computer network.

A software prototype, INFOSAE, was developed to be original in relation to contributing to the nursing departments of small hospitals or hospitals with restricted resources regarding their computer network. Because of the flexibility in its implementation in any hospital context, it adopts the Android mobile platform to install the mentioned software and apply the nursing process at bedside.

This proposal fills the gaps found in previous published studies, such as: a software prototype for the Systematization of Nursing Care⁽³⁾, which demonstrated limitations both in the capacity to store and process data and in the free text typing; the nurses had difficulty to use pen laser pointers due to the reduced size of the screen of the mobile device.

Another study, the SIPETI – Information System with the Nursing Process⁽⁴⁾, adopting the desktop platform, demonstrated a disadvantage in its use by including the mobile desktop at bedside, as the units were not always compatible with the use of a laptop.

A study on the installation of the MEDCART[®] system, also adopting the desktop platform in a cardiology institution⁽⁵⁾, found additional charges to expand the infrastructure of the wireless communication network of the hospitalization units to build the mobile computer prototype.

A dissertation on the Computer System in Nursing⁽⁶⁾ using the web platform, showed that despite its low cost (as it uses open source in order to be a multiplatform system), a mobile module was not developed so that the system could be fed directly at bedside, unlike the present proposal. In the light of the above, the objective of the present study was to develop a prototype software, named INFOSAE, to apply the Nursing Process in mobile technology at bedside, which may be used in the desktop and web platforms.

OBJECTIVE

To describe the development of the INFOSAE software in the mobile modality at bedside in order to apply the nursing process in clinical units of a general hospital, allowing the assessment of its usefulness by the nurses.

METHOD

Ethical aspects

As established by Resolution 466/2012 of the National Health Council the participants of the research were informed about

the aims of the study, and then signed a free and informed consent form. The research was approved, registered, and filed in the National Information System on Research Ethics Involving Human Beings - (SISNEP).

Theoretical and methodological framework

The development of the system was guided by software engineering based on the prototyping model, which enables users to verify whether the system supports the task to which it was designed. New ideas for the needs of users may also be obtained, as well as finding strengths and weaknesses of the system, proposing new functionalities⁽⁷⁾. This model is developed in three stages: specification, development, and validation.

The specification stage relates to the requirements that summarize what should be done in a software development process. In this stage the best technical solutions are to be studied and defined in relation to model/architecture, programming languages, and database management systems. The development stage consists of the generation of a corresponding set of outcomes and interventions for the nursing diagnoses provided by user nurses, and is based on the idea of performing an initial trial to the successive refinement until reaching the finished product. The final stage of the process consists of the validation of the prototype, performed during the training stage of the user nurses, as they need some time to become familiar with the new system and make it work in the normal standard of use, expecting to find out possible errors and omissions to be fixed, as well as including the necessary innovations⁽⁷⁾.

Type of study

Qualitative applied methodological study for technological production of software named INFOSAE⁽⁸⁾.

Methodological procedures

Study setting

A university hospital located in a large capital city in the Northern region of the country. The place was chosen because its clinical units were part of the pilot project for implementation of a nursing project by the Nursing Department, and because the local nurses had been recently trained, becoming familiar with the application of the nursing project.

Data source

Eight nurses were selected by the following criteria: assigned and working in different on-duty shifts in the clinical units of the university hospital, and working within the period from October 2014 to September 2015.

Data collection, data organization, and work stages

The procedures of the proposed software development model were carried out as follows.

The following technologies were used in the specification stage for the development of the INFOSAE:

Python – As a programming language, chosen for the high level of agility provided by its lexical and syntactic structure.

Django – As a web framework built with the Python language, which provides a new model for implementation of the

MVC (Model View Controller) project standard, introducing some flexibility in the development, testing, and installation of the application.

Postgresq1 – As a relational database, chosen for its high level of performance in large-scale databases.

Android – Operating system produced by Google company for smartphones.

The database of the INFOSAE was generated in the development stage, consisting of information provided by nurses of the clinical units, choosing among the list of nursing diagnoses of NANDA I – 2012/2014⁽⁹⁾ those that were more in line with the predominant pathological statuses in patients admitted in those units.

Sixty-four nursing diagnoses classified according to the theory of Basic Human Needs (BHN) were selected to make up the system database: 49 in psychobiological needs, 13 in psychosocial needs, and 2 in psycho-spiritual needs.

Each category of the nursing diagnoses was organized into subclasses: in Psychobiological needs, 14 subclasses (Physical activity, Body care, Eliminations, Hydration, Physical integrity, Nutrition, Oxygenation, Vascular regulation, Neurological regulation, Thermal regulation, Hormonal regulation, Sensory perception, Physical safety, and Sleep/rest); in Psychosocial needs, 5 subclasses (Self-esteem, Communication, Education for health, Gregarious, and Emotional security); in Psycho-spiritual needs, 1 subclass: Religion.

These subclasses were extracted from basic literature: “Nursing diagnoses, interventions, and outcomes: subsidies for the systematization of the professional practice”⁽¹⁰⁾ and “Nursing process in clinical practice: case studies conducted in the Clinical Hospital of Porto Alegre”⁽¹¹⁾.

The nursing diagnoses were defined with corresponding standards of expected outcomes and nursing interventions, as already used and present in the literature “NANDA, NOC-NIC links”⁽¹¹⁾. Fifty-four expected outcomes were selected from the NOC (Nursing Outcomes Classification) and sixty-four interventions from the NIC (Nursing Interventions Classification).

This development stage considered several work meetings of the research team with the software engineer to organize the functional requirements in the system with elements of the database. The API (Application Programming Interface) was selected through the REST (Representational State Transfer) to assist the nursing process application process with an interface provided through the mobile application for Android platform that enabled the use of resources at bedside. This software prototype with architecture based on the REST – API model has the system requirements available in the HTTP protocol, and is universally supported in all professionally used programming languages.

In the validation stage the created prototype was initially tested at the same time the nurses were trained. This training included the practical familiarization with innovations in the daily work, recommending the use of standards specifically written to implement the nursing process in their patients, and the programmed individual testing for application of the INFOSAE to selected patients with the use of a tablet at bedside.

During this stage the software engineer adjusted and improved the INFOSAE with the support of the research team, which provided practical suggestions for changes or additions based

on observations by the nurses that were becoming familiar with the nursing process modules implementation system. It was essential to train the user nurses for the use of this technology, because competent use has a critical impact on the provision of an effective information system⁽¹²⁾.

Finally, in the assessment of the attributes of its usefulness, the nurses that participated in the INFOSAE testing answered an instrument developed to obtain from them an assessment of this software.

RESULTS

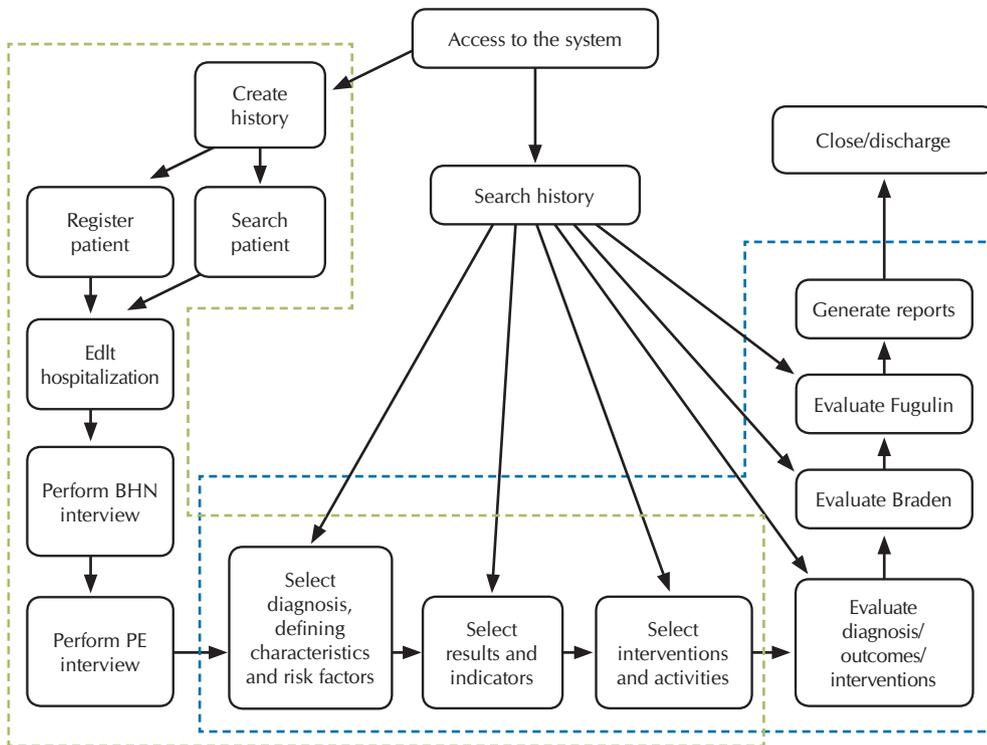
The so-called INFOSAE system was structured with the support of the API-REST architecture, presenting a user nurse login screen. The nursing process creation screen includes: the menus History (of the patient), Patient (name), NANDA (list of nursing diagnoses). Nursing process maintenance screen, with 11 menus: Header, Patient, Basic Human Needs – BHN, Physical Exam, Braden (patient risk and pressure ulcer rating scale), Fugulin (scale for team sizing according to profiles of patients with different levels of nursing dependency), Diagnoses, Outcomes, Prescriptions, Annotations, Impressions, and Main Menu. The nursing history is obtained through interview and physical exam. The interview collects the BHN and identification data of the patient. Figure 1 shows the flowchart of the software that characterizes the full operation of the system in the approach and care provided to patients from their admission until discharge.

Basic human needs data are: Psychobiological, Psychosocial, and Psycho-spiritual, as shown in the example of Figure 2. In the physical exam the signs and symptoms are observed following this order: Skin and tissues; Neurological regulation; Perceptions Organs/senses; Cardiovascular regulation; Pulmonary regulation; Thermal regulation; Breast; Abdominal region; Genitourinary and Menstrual Cycle; MMSS (upper limbs); MMII (lower limbs).

Upon completing the nursing history stage, the system presents a list of nursing diagnoses according to the data obtained in the interview and physical exam. For example: selecting in the system the options dyspneic, bradypneic, tachypneic, snoring, wheezing, rales, pleural friction, chest pain, cough, and expectoration, the software will present the following nursing diagnoses to the selected signs/symptoms:

- #00030 - Impaired gauze exchange;
- #00032 - Ineffective breathing pattern;
- #00033 - Impaired spontaneous ventilation;
- #00031 - Ineffective airway clearance.

In practice, after selecting the priority nursing diagnoses according to the clinical judgment by the nurse, the system presents a list of defining characteristics, related factors, and risk factors for each selected nursing diagnosis, making it possible to mark the most appropriate one to the clinical conditions of the patient shown in Figure 3 for the nursing diagnosis chronic pain. After the selection of the nursing diagnoses, the system presents a list of expected outcomes of the NOC classification for each nursing diagnosis demonstrated in Figure 4. By selecting an expected outcome the system presents the indicators and scales of that expected outcome to identify the target gradation or score of the outcome.



LEGEND

- - - - - Maintenance phase
- - - - - Creation phase (patient admission)
- BHN Basic human needs
- PE Physical examination

Figure 1 – Flowchart of the software

For each selected nursing diagnosis, the nurse has access to a nursing prescription list selected from the NIC classification corresponding to the diagnosis observed in Figure 5.

The nursing prescriptions are arranged in two ways: per shift (M, A, E) and per schedule. In the assessment of the care, the nurse may follow the nursing diagnoses, expected outcomes,

and nursing prescriptions from the date of admission to the date of discharge of the patient. INFOSAE was programmed to allow the insertion of new nursing diagnoses, expected outcomes, and nursing prescriptions, as well as the Braden and Fugulin scales. During the development process of INFOSAE, the nursing department of the hospital decided to use the Braden and Fugulin scales, indispensable: one for the control of pressure injury incidence in hospitalized patients, and the other for the appropriate sizing of the nursing staff in the unit. This inclusion – a need of the nursing department – was only possible due to the flexibility of the software. The nurses participating in the study were mostly female (75%) and aged between 30 and 39 years. Regarding professional practice, all of them reported to follow the nursing process methodology. And regarding familiarity with computers, all of them used it for more than 4 years, both at home and at work, for about 7 hours a day. The nurses that assessed the INFOSAE system agreed with the

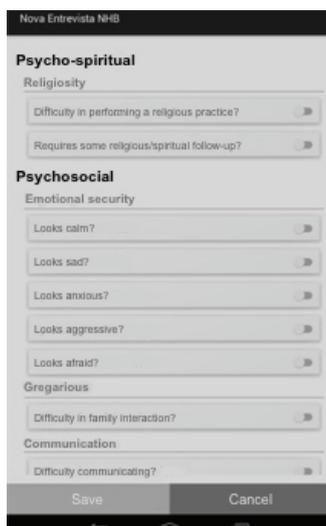


Figure 2 – Nursing history collection screen



Figure 3 – Screen – Nursing diagnoses

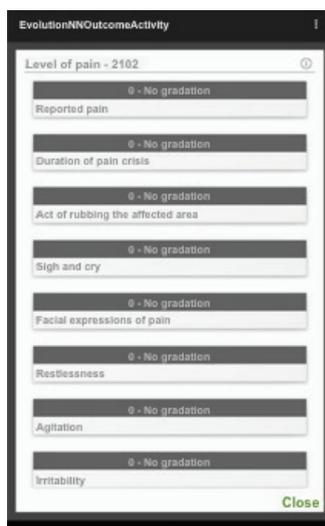


Figure 4 – Screen – Expected outcome



Figure 5 – Screen – Nursing prescription

proposed menus, and all of them answered positively to the easiness to learn and use the system, as well as considered it very useful. They reported the easy and difficult aspects related to the use of the INFOSAE and suggested several operational changes to the system, which were accepted and incorporated during the system testing and validation.

DISCUSSION

INFOSAE was conceived having the nursing process based on the BHN theory, which was already adopted in the nursing practice of the studied hospital, allowing a continuity of the nursing actions in the institution. It is worth noting the importance of the use of a theoretical framework that is already known and accepted by the nursing team as it facilitated the adherence of the team to the new methods of work, including the computerization of the nursing process⁽¹³⁾.

In the INFOSAE the nurse selects the options in the system, and may also add other information that is not present in the content of the database. As observed in another study, the screens developed to the prototype were configured to facilitate the understanding of the user in relation to the use of the system and the application of the nursing process in order to prevent visual pollution by data repetition, establishing a pattern to facilitate the final design of the system⁽¹⁴⁾. The future of clinical decision support systems depends on progresses in the development of useful software aimed to reduce the existing logistical barriers in their implementation⁽¹⁵⁾.

In the creation and maintenance of the nursing history there was an effort to adapt the INFOSAE to the reality of the practice of the nurses at the studied unit so they were confident to develop the nursing process in the system. The development of a system that considers as much as possible the clinical assessment process of the patient provides nurses with a higher level of confidence in the nursing care decision-making process according to the complexity of the clinical situation of the patient⁽¹⁶⁾.

The Braden and Fugulin scales included in the INFOSAE could only be incorporated here as complementary instruments because of the advantages of open, dynamic software engineering that allowed the system to be maintained up-to-date over time⁽¹⁷⁾.

Nursing diagnoses are generated based on the information of the BHN theory and the physical exam selected by the nurse: the INFOSAE presents a list of nursing diagnoses in which the selection by the nurse is based on the clinical reasoning and critical thinking to choose the priority nursing diagnoses. Information systems in healthcare are used to assist professionals in the decision-making process of nursing diagnoses and the corresponding care interventions. Nurses are the professionals who choose the nursing diagnoses that reflect the condition of the patient and the care intervention needs⁽¹⁸⁾. The computerized system supports the generation of nursing diagnoses based on specific data of the patient, care plan, and implementation within the nursing workflow⁽¹⁹⁾. Information systems in the nursing area offer advantages to the work of nurses by providing visibility to their actions and helping them to make decisions in different situations. It is important to mention that the system cannot replace nurses' critical thinking, ability to act, and ability to perform⁽²⁰⁾.

After the selection of a nursing diagnosis for a patient, the INFOSAE presents an automatic view of the corresponding expected outcomes and nursing prescription so that nurses may accept or reject them, as the system allows them to select those considered more pertinent to the patient, ensuring the individualization of the application of the nursing process. The same experience has been related in the practice of computerization of the nursing process in a private hospital in the state of São Paulo, where the authors emphasize the fact that the practice of this scientific method allows the patient to be assisted with individualization and consequent disclosure of the quality of care by the institution⁽²¹⁾.

The nursing outcome based on the NOC taxonomy appears to meet a requirement for hospital accreditation: assessment of nursing actions. Data collected in another study enabled the analysis of the efficiency of the computerized nursing process using indicators generated by a system in an ICU in which the nurses identified the problems and risks for the patients, planning systematized care⁽²²⁾. Composing the database of the nursing information system, the NIC interventions list facilitates nursing practice and provides data to carry out research that will contribute to a higher visibility to the work of nurses⁽²³⁾. Nurses need to document the care provided to the patient, a task that is facilitated by the documentation of the computerized nursing process application system, with the use of a standardized terminology in favor of the analysis of the efficacy of care and safety of the patient⁽²⁴⁾.

The nurses that assessed the system reported to be already familiar with the methodology of the nursing process and to be experienced in the use of a computer at home and at work, a fact that contributed to their agreement to participate in the study of INFOSAE. They assessed the INFOSAE satisfactorily, which is essential to improve the system as the contribution of the users provides the adaptation of the software to their own needs.

The assessment of the system is essential at all times of its implementation, both in the testing and in the so-called adoption. For example: a series of operational difficulties were observed during the training for the use of INFOSAE. One of these was identified by a nurse, as follows: *"It is necessary to improve the continuity of certain processes, that is, [it is necessary] an icon indicating the next step to be implemented"*. The problem was reported to the software engineer, who designed a screen with the three stages of the nursing process: nursing diagnoses, outcomes, and interventions, thus providing a solution for this issue.

The participation of the user nurses in this stage was essential to improve INFOSAE in clinical practice, as it is necessary in the development of an information system not only in this one, but in all the stages of its development. The participation and collaboration of the nurses make them more receptive to the use of technology in their practice, making them more sensitive and committed to its adoption⁽²⁵⁾.

Study limitations

By the end of the successful development of the INFOSAE software, which was performed in a natural hospital context lacking NP informatization, it was expected that the process would have promoted the continuation of routine nursing actions

in the clinical units where the study to place. This fact shows a limitation and how frail the research process was, considering strategies for incorporating good research results into the daily practices of health services.

Contributions to nursing

The INFOSAE software prototype was developed in a mobile platform. It can be used in any of the three main current platforms (mobile phones, desktop and web) and implemented in operating network structures. This represents a unique contribution to the nursing practice in hospitals that still lack a computerized system for the application of the nursing process, as it allows a low-cost implementation, as an autonomous or complementary tool to their computational environment. Therefore, the INFOSAE can be used together with other systems in operation, without major changes in the network structure, with safety and good performance.

CONCLUSION

The INFOSAE software prototype in the mobile modality at bedside represents an innovative, easy-to-apply computerized technology. The assessment of use of the system was confirmed by the user nurses that participated in the entire development process, from the specification to the validation of the system. In short, the nurses expressed the following statements in relation to the adoption of INFOSAE:

- useful, easy-to-use instrument, capable of speeding up the service;

- ease to use, compiling several instruments and printed materials in one single system;
- allows a general overview of all patients in one single application;
- although the INFOSAE requires more time for inclusion of data, it presents the advantage of making the nursing process more complete.

The aim was successfully achieved, with the advantage that this software is in the mobile platform in REST architecture, allowing it to be used in any of the three main current platforms (mobile, desktop, and web) as well as to be implemented in existing computer network structures.

Advantages of the INFOSAE software include the possibility of being used as an independent or complementary tool to the computer environment as its convergence allows a low-cost implementation; also, it may coexist with other systems in operation without significant changes in the network structure, with safety and good performance. In addition, INFOSAE arises as an open, dynamic system, able to incorporate innovation and updates at any time, whenever necessary.

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