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INTEGRATIVE REVIEW ARTICLE

# SOFTWARE DEVELOPMENT FOR NURSING CARE: INTEGRATIVE REVIEW

## DESENVOLVIMENTO DE SOFTWARE PARA O CUIDADO DE ENFERMAGEM: REVISÃO INTEGRATIVA

## DESARROLLO DE SOFTWARE PARA EL CUIDADO DE ENFERMERÍA: REVISIÓN INTEGRAL

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**ABSTRACT**

***Objective:*** to evaluate the national and international scientific literature on knowledge applicable to the nursing care software development process. ***Method:*** an integrative review, which answered the question << How is the software used in nursing care developed? >>. The search was conducted in the databases LILACS, CINAHL, PubMed / MEDLINE, Scopus, the Cochrane Library databases, the Brazilian Digital Library of Theses and Dissertations (BDTD), and portal periodicals theses and dissertations of CAPES, employing the descriptors: nursing care, software and software validation. ***Results:*** nine Articles were selected, four dissertations and a thesis, a total of 14 productions. Predominant models of traditional approaches: linear or classic and prototyping for care software support and Instruction Aided by computer for educational software. He realized the importance of the evaluation stage of the software for its evolution. ***Conclusion:*** Nursing must approach the software development method to ensure their usefulness and validity. ***Descriptors***: Software; Software Validation; Nursing Care.

**RESUMO**

***Objetivo*:** avaliar a produção científica nacional e internacional sobre o conhecimento do processo de desenvolvimento de ***softwares*** aplicáveis ao cuidado de enfermagem. ***Método*:** revisão integrativa, que respondeu à questão <<Como são desenvolvidos os *softwares* utilizados no cuidado de enfermagem?>>. Foi realizada a busca nas bases de dados LILACS, CINAHL, PUBMED/MEDLINE, SCOPUS, nos Bancos de dados COCHRANE, na Biblioteca Digital Brasileira de Teses e Dissertações (BDTD), e no portal de periódicos de teses e dissertações da CAPES, empregando os descritores: cuidados de enfermagem, software e validação de *software*. ***Resultados*:** selecionaram-se nove artigos, quatro dissertações e uma tese, totalizando 14 produções. Predominaram modelos de abordagens tradicionais: linear ou clássico e prototipação para os softwares de apoio assistencial e Instrução Auxiliada pelo Computador para os *softwares* educativos. Percebeu-se a importância da etapa de avaliação do software para a sua evolução. ***Conclusão*:** a Enfermagem precisa aproximar-se do método de desenvolvimento de software para garantir sua utilidade e validade. ***Descritores*:** Software; Validação de Software; Cuidado de Enfermagem.

**RESUMEN**

***Objetivo:*** evaluar la producción científica nacional e internacional sobre el conocimiento del proceso de desarrollo del softwares aplicables a la atención de enfermería. ***Método:*** revisión Integrativa, que respondió a la pregunta << Como son desarrollados los softwares utilizados en el cuidado de enfermeira? >> Se llevó a cabo la búsqueda en las bases de datos LILACS, CINAHL, COCHRANE, PUBMED/MEDLINE, SCOPUS bases de datos, en la Biblioteca Digital Brasileña de Tesis y Disertaciones (BDTD) y periódico portal de tesis y disertaciones de la CAPES, utilizando las palabras clave: enfermería, software y software de validación. ***Resultados:*** se seleccionaron nueve artículos, cuatro disertaciones y una tesis, totalizando 14 producciones. Predominaron los modelos de enfoques tradicionales: linear o clásico y prototipos para los softwares de apoyo asistencial y enseñanza asistida por computadora para el software educativo. Se percibió la importancia de la etapa de evaluación del software para su desarrollo. ***Conclusión:*** la Enfermería necesita abordar el método de desarrollo de software para garantizar su utilidad y validez. ***Descriptores*:** Software; La Validación del Software; Cuidados de Enfermería.

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## INTRODUCTION

Technological advances have intensified in the twentieth century and marked a new era in health care. The influence of technological innovation is remarkable, both in terms of availability of equipment or new care techniques on different fields or specialties. So the clinical and epidemiology knowledge, the cultural dimension of the health-disease process and organizational models and work management are impacted.[1]

In this context, computers are inserted to be considered in the health sector as a driver of technological progress. It is believed that nursing care can achieve levels of excellence through adherence to technological resources in information available today. Such resources should be integral elements of the nursing care context as a support tool for obtaining data, and to generate new information and knowledge. [2]

Computer science in nursing becomes relevant to the nursing work process at different levels of health system performance. The use of *software* applicable to nursing care is a challenge faced in many parts of the world, it allows the recovery of data and information relating to clinical decision making in nursing, fundamental requirement for evidence-based practice, and can contribute to the development of research in nursing.[3]

In Brazil, it has shown positive aspects in the use of nursing care software like computerized care planning streamlining collection activities, registration, storage, manipulation and retrieval of patients in the nurse's responsibility. Besides the ease of access to data, it enables administrative instrumentalization and decision making.[4]

To create and use *software* in nursing it is imperative for nurses to appropriate and have a defined *software* development process. This appropriation can avoid the low quality of the final product, dissatisfied customer and high maintenance costs. Thus, the development of this technological arsenal, there are different models of software processes, but some activities are fundamental, regardless of the model chosen. The activities are: Software Specification; Design and Implementation, Validation and Evolution.[5]

It is noteworthy that the software specification defines its functionality and restrictions on their operations. The design and implementation defines the production of software that meets the specification; validation is to ensure that the software does what the customer wants and evolution allows the software to evolve to meet the needs of the client.[5]

In the development of computer systems it is difficult to require higher technical training, both in relation to nursing knowledge, information technology and programming.[2] Therefore it becomes important to identify methodological aspects adopted in the construction of applicable nursing care *software*, as well as limitations and suggestions of authors in order to support future research software development.

Based on these, the following question was elaborated: How is the software used in nursing care developed? Therefore, this study aims to assess the national and international scientific literature on the knowledge about the applicable to nursing care *software* development.

## METHOD

Integrative review developed following six steps: 1. Development of a guiding question; 2. Search or sampling in the literature; 3. Data collection; 4. Critical analysis of the included studies; 5. Discussion of results; 6. Presentation of integrative review.[6-7]

The literature search took place in June and July 2013 in the following databases: **Latin American and Caribbean Health Sciences (LILACS); Cumulative Index to Nursing and Allied Health Literature (CINAHL); PubMed / MEDLINE; Scopus and Cochrane**.

For the selection of the sample in the database was established as inclusion criteria: the publication that brings the description of the *software* development process and is released in English, Portuguese or Spanish. Thus, dissertations, theses, reports, news, letters to the editor and those that were repeated in the databases were excluded.

The following descriptors or keywords belonging to the Descriptors in Health Sciences were used (DeCS) of the Virtual Health Library and the Medical Subject Headings (MeSH) of the National Library of Medicine: Nursing care; Software and Validation software.

In CINAHL®, we used the nursing care and validation software or software descriptors and obtained 154 results. Of these, three were selected, ten were not available online and 141 studies were not related to the theme. In Pubmed, the selected descriptors were nursing care and software totaling 310 studies, of which 24 were available in full online. However, there was a repeated article, 19 were not related to the theme, and

four studies were selected.

LILACS, crossed nursing care descriptors and software or software validation, and found 57 results. Of these, one was repeated, six were not available online and 48 did not answer the main question. Thus, two studies were selected.

In the Scopus and Cochrane Database, descriptors used were nursing care and software validation and software. In Scopus, initially 259 studies were found. However, when refining to nursing, it was only 78 results. It was noticed that, of these three were repeated, six were not available online, and 69 did not answer the main question. Therefore, no study has been selected in SCOPUS. Cochrane, gave 155 results, but none of the studies served the purpose of this search.

For the selection of publications we initially read the title and summary to confirm that they contemplated the guiding question of this investigation and would meet the inclusion and exclusion criteria. Then it came to the reading of the articles step. At this time, it was found appropriate to expand the search to the Bank Thesis of Higher Education Personnel Improvement Coordination (CAPES) and Brazilian Digital Theses and Dissertations Library (BDTD) because information relating to methodological steps identified in the articles were succinct, with a view to limiting the number of pages recommended by the magazines for publication of studies.

In BDTD and CAPES thesis database, the terms nursing care and software were used. In BDTD, found to be 98 results, three studies being selected. CAPES thesis database yielded 106 results, two studies corresponded to articles already selected in the database, so, it was considered as repeated, one could not be found online, and two studies were selected. It is noted that the selection of thesis and dissertations followed the inclusion criteria meeting the guiding question and being available in full online. The selection of studies is exposed in the data in figure 1.

| Articles/Source | Cinahl | Pubmed/ Medline | Lilacs | Scopus | Cochrane | BDTD | CAPES | Total |
|---|---|---|---|---|---|---|---|---|
| Found | 154 | 310 | 57 | 259 | 155 | 98 | 106 | 1139 |
| Did not answer the guiding question | 141 | 19 | 48 | 250 | 155 | 94 | 101 | 801 |
| Repeted | 00 | 01 | 01 | 03 | 00 | 00 | 02 | 07 |
| Not available | 10 | 286 | 06 | 06 | 00 | 00 | 01 | 309 |
| Selected | 03 | 04 | 02 | 00 | 00 | 03 | 02 | 14 |

Figure 1. Selection of research papers in the databases CINAHL, PubMed / Medline, Lilacs, Scopus and Cochrane database, theses database of CAPES and BDTD, according to the established inclusion criteria.

To collect the information, we used an adapted[8] script involving the following issues: the publication title, author, year, type of study, methodological framework, software process model, methodological steps, software purpose, professionals involved in software construction, methodological limitations of the study, the authors' recommendations and level of evidence.

Evidence levels correspond to a variation I to VII. They are: I- systematic reviews or meta-analysis of relevant clinical trials; II- Evidence derived from at least one randomized controlled clearly delineated clinical trial; III Evidence obtained from well-designed clinical trials without randomization; IV- cohort studies and well-designed case-control; V- systematic review of descriptive and qualitative studies; VI Evidence derived from a single descriptive or qualitative study; VII- evidence from officials of opinion and / or report on specialist committees.[8]

The organization and discussion of the results was performed descriptively, subsidized by the theme of literature study in the areas of information technology and nursing.

## RESULTS

This study analyzed nine studies, four dissertations and a thesis. The articles were found, mostly in the Pubmed / Medline (04) and CINAHL databases (03). Regarding the periodic and language, three were published in American magazines (English language), one in a Cuban magazine (Spanish language) and five in Brazilian magazines (Portuguese language).

Dissertations and thesis were developed in graduate Nursing programs in the Southeast (4) and South (1) of Brazil. It was observed that almost all studies (13) were developed from 2000.

On the design of the studies and data analysis, weak points were found in various surveys, as were joint descriptive studies.[9-12] Still, four studies did not define the type of study.[13-6] This way, all were classified as level VI of evidence.

By analyzing the work of the purpose of the *software* it was noted that seven were about *software* to support nursing care. Thus, intended to contribute to patient classification regarding necessary care [9-17] and automation of diagnosis and nursing interventions. [11,13,15,18] Six were from educational *software* that were characterized as hypermedia for use in nursing education,[12,16,19] in continuing education of nurses [20-21] and health education for family caregivers of elderly.[10] Only one had the administrative purpose of dimensioning of Nursing Professionals (DIPE).[22]

The methodological references, ten papers employed models of *software* processes in accordance with table 2. The prototyping model and cascaded linear or classic were chosen primarily for the development of nursing care support *software* in four[10,13,15,22] and two works, respectively.[9-18]

It was observed that for the development of educational *software*, the Model Instruction Aided by Computer (CAI) was the most used, being coupled to the following theoretical frameworks: Bernardo (1996), Paulo Freire, Price (1991), Falkembach (2005) and Gagné (1980). It was noticed that only one study (14) adopted a *software* process model considered more agile in its development, as a recent trend in IT.

It was evident that six jobs discoursed on the *software* evaluation phase, considered essential for the evolution of *software* and, consequently, the quality of the final product.[10,12,14,16,20,22] Most studies [9,11-2, 15,17,20,22] made explicit involvement of IT professionals for *software* development.

| Author/Year | Software process model | Methodological Reference | Methodolological stages |
|---|---|---|---|
| Chambers et al, 2003 | Prototiping | Poulson, Ashby and Richardson (1996) | Survey of target audience needs through focus groups and questionnaires. Software development project. Evaluation tests with questionnaires. |
| Luo and Tang, 2009 | Prototiping | Not mentioned | Grouping of nursing language from the use of NANDA and NIC and development of the prototype. |
| Lepage et al, 1995 | Cascade, linear or classic model | Not mentioned | Specification through the survey of healthcare reality of nurses (interviews). Validation and implementation. |
| Sperândio and Évora, 2005 | Prototiping | Pressman (1995) | Collection and refinement of requirements (Study of systematization of care that was done manually). Software Development. |
| Santos, 2010 | Unified Process | Larman (2007) and Costa (2001) | Analysis of the forms used by the nursing service that make up the record. Interviews with nurses to grasp the characteristics, knowledge and insights to develop the nursing system. Evaluation and validation during the development process with nursing students and nurses. |
| Villalón, 2008 | Not defined | Not mentioned | Literature search and critical analysis. Construction of software development guide. Software development and validation. |
| Freitas et al, 2012 | Not defined | Vygotsky | Phase 1 - Construction of Hypermedia (Survey content and planning modules, media Production and organization of tutorial units, organization of spaces for student and tutor and communication between them, development of hypermedia and available hypermedia). Phase 2 Validation of hypermedia |
| Lopes, Silva and Araújo (2004) | Not defined | Thagard (1998) | Interface definition. Database development. Data crossing way. Database power and establishing parameters for analysis of selected data. |
| Fernandes, Barbosa and Naganuma (2006) | Model of Instruction Aided by Computer (CAI) | Price (1991) Gagné (1980) | Planning. Instructional Content Development and Assessment. For the evaluation. were prepared six instruments in which were set the items to be evaluated, such as objectivity of content, updated information, theme scope, used vocabulary, form of presentation of content (didactically), content description and content distribution . |
| Pereira (2011) | Prototiping | Sperândio (2008) Aguiar (2006) Caetano (2006) and | Evaluation. Definition of quality requirements for evaluation and assessment procedures with application tools. |

| | | | |
|---|---|---|---|
| | | Rodrigues (2008) | |
| Novelli and Castro (2008) | Not Defined | Not mentioned | Distance Education and Information Technology in Health Nucleus UNESP produced the software. |
| Goés (2010) | Model of Instruction Aided by Computer (CAI) | Bernardo (1996) Paulo Freire | 1. Scope Definition (literature, braistorming, user characterization and analysis of resource availability)<br>2. Planning (Construction flowcharts presentation, interface design, chronological planning, financial support verifying and necessary computer resources and or additional. Prototyping. Stage of approval)<br>3. Production (Meeting of drafts, media processing, creation of a database, authoring and programming, error analysis in the planning and approval phase)<br>4. Implementation (Application of Critical analysis, analysis of authoring and publishing tools, user acceptance test, final review of the project, implementation, post-implementation review and distribution) |
| Martins (2011) | Cascade, linear or classic model | Bezerra (2007) Melo (2002) Lopes et al | Analysis of the requirements. Codification. Programming. Specification and system architecture. |
| Xelegati (2010) | Model of Instruction Aided by Computer (CAI) | Price (1991) Falkembach (2005) Gagné (1980) | 1. Initial Planning<br>2. Planning and development of instructional content |

Figure 2. Characterization of the sample to the software process model, methodological framework and methodological steps.

The limitations of the studies mentioned the difficulty related to the political will of the public service for *software* development projects, the power of the database that requires exhaustive typing, the expensive cost of this type of research that can intimidate creation initiatives in the area of nursing. However, in general, the authors point out that software produced to support nursing care reduces the time spent on paperwork, enabling nurses, greater dedication in direct care, and educational *software* are innovative tools that enhances the educational process.

## DISCUSSION

It is important to realize that Brazilian nursing excelled in scientific publications when it involved *software* development theme for nursing care. However, it is emphasized that this finding does not mean dominance of *software* production technologies by Brazilian nurses, but they describe, in their articles, the methodological steps for building *software*, a central question of this study.

The findings of this study were similar to other studies as the year of publication, methodological design and origins of dissertations and theses. Thirty-seven studies were analyzed between dissertations and theses on the development of software for health and nursing and identified mainly descriptive studies, conducted from 2000 in the South and Southwest.[23]

Nursing has care as the core of its activities and it can be understood as a complex construct with different dimensions involved and develop actions, attitudes and behaviors that are based on scientific, technical, personal, cultural, social, economic, political and psycho-spiritual, seeking promotion, maintenance or restoration of health, dignity and human totality. Consequently, care and technology are also interconnected, since nursing is committed to principles, laws and theories, and the technology is the expression of scientific knowledge in their own transformation.[24-5] Moreover, researchers have attributed theoretical and methodological approaches between the systematization of nursing care and *software* engineering. It was observed that the software building process occurs in layers or dimensions that rely on a compromise focused on organizational quality.[26]

The *software* development initiative applied to nursing care, considering its multidimensional feature is still in its infancy. Creating *software* for nursing care is aimed at strengthening the computerization of the systematization of nursing care and the educational processes.

These results appear to be consistent with the global reality. In 2012, the Brazilian Nursing promoted the 3rd International

Symposium on Nursing Computing: Challenges and Advances in training and care (III SIIEnf). The themes addressed in research were predominantly on the implementation of electronic documentation of the nursing process and the adoption of undergraduate teaching technologies, graduate in nursing and continuing education of Nursing professionals.[2]

In the analyzed studies, we identified the *software* process model, understood as a set of activities, actions and tasks required to develop quality *software*.[27] There was a predominance of traditional approaches, among them the cascade, linear or classic model and prototyping, especially in welfare purpose *software*.

A study revealed similar findings when investigating methodologies and nursing classification systems used in the construction of information systems in enfermagem.[28] In the cascade model, each step should not be started before the previous stage has finished and each phase transition is one or more approved documents. Due to manufacturing costs and approval documents, iterations are costly and involve significant rework because the design only passes once through this cycle. Once the requirements were defined and the implementation phase initiated, the requirements are frozen and cannot change. The premature freezing of requirements may prevent the system to the customer's goal. It is a model that should be used in projects where the requirements are well understood. We still use a lot of this model despite warnings from researchers in the field that have identified problems in adopting them.[29]

The prototyping process basically consists of several interactive cycles, with the aim of building a prototype from initial requirements. A prototype of critical assessment is realized which considers the initial requirements and requirements that were not mentioned initially. Prototypes can be used to reduce the time required to develop user documentation and train users on the system.[5]

Some drawbacks of the prototype can be highlighted, for example, the modeling is started early, without having focused attention enough to the analysis of a current and desired situation, recognition of the problem and the problem formulation are at least as important as the actual solution. A final danger is that prototyping can handle enthusiasm of the end user. The prototyping process can give the end user the impression that almost any suggestion can be implemented, regardless of the development process stage in which it finds itself.[29]

It is worth emphasizing that in 2001, one methodologists, group defined a manifesto to encourage better ways of developing software, called the Agile Manifesto. Thus, the aim was to standardize its processes and unify common principles from agile development methods. It was portrayed as fundamental principles of agile methods: interaction between more than processes and tools individuals; product more than working extensive documentation; collaboration with the customer more than negotiated terms (contract); responses to changes, more than fulfilling plans.[30]

It was evident that nurses are not appropriated agile methodologies for building software because only one study (14) adopted the Unified Process that fits this profile. This is an attempt to build on the best features and characteristics of conventional *software* process models, but feature them in a way that implements the best principles of agile *software* development.[27]

It is known that investments for the technological development of nursing care are increasing, and that nurses establish increasingly positive expectations on this scenery.[3] Therefore it is necessary to incorporate the principles of agile methodologies in nursing in order to ensure safe and effective technological innovations.

The model Instruction Aided by Computer (Computer Assisted Instruction - CAI) was used preferentially in the hypermedia educational software type. This model recommends the following stages: 1. Initial planning; 2. planning and development of instructional content and assessment and revision.[3,31] The type CAI programs can be classified in categories: exercise and practice; tutorial and simulation, as well as resolution of problems.[32]

The CAI has proved to be an appropriate methodology in the production of educational hypermedia in nursing. The use of new educational technologies has contributed to the paradigm shift in the training of professionals in health institutions and thus in promoting qualified nursing care.[20]

As regards the methodological steps it was found that most of the studies did not show the data evaluation *software*, which hinders their evolution. It is understood that after the solids systems have implemented they must be reevaluated in order to remain useful. After the *software* is put into use, new requirements emerge and existing requirements change. *Software* of the parts can be modified to correct errors discovered during its operation, to adapt them to a new

platform and to improve their performance. *Software* development, therefore, does not stop when a system is delivered to the operation, but continues throughout the life cycle system.[5]

Thus, it is understood that the *software* developed for nursing care cannot meet all the quality criteria recommended by experts in the field. Therefore, the recent initiatives of nurses who seek to identify the requirements for the construction of *software* are valid.[33]

## CONCLUSION

The appropriation of models of *software* processes by nurses is still incipient, considering that the models used were those of traditional approaches, which highlights the need for deeper understanding of this issue in the field of nursing. In addition, some studies have not defined them as the reference of computing.

Among the models used, it was realized that the model in cascade, linear or classic and prototyping were the most used for *software* with care support purposes and for educational software. The Computer Aided Instruction (CAI) seems to contribute to better results, however, among the traditional approaches identified, it was observed that the recommendation to evaluate the *software* under development was not met, although some authors have pointed out this intention for future projects. Thus, the *software* produced for the nursing care is fragile and cannot meet the real purpose.

In this investigation, we obtained a few jobs that did not allow to portray the current situation of *software* development studies for nursing care, mainly by not detailing the methodology in the articles. It is emphasized, therefore, the urgency of developing new studies on this topic and providing the reader with being able to contribute information for replication or understanding of the foregoing, since the incorporation of this technological resource in the health sector is growing and nursing has been following this trend.

Nurses need to be even closer to the theoretical and methodological framework of *software* development, in order to minimize errors and costs, allowing you to create applicable and valid *software* for nursing care.

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