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The Care Management Information System for the Home Care Network (SI GESCAD): support for care coordination and continuity of care in the Brazilian Unified Health System (SUS)

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Abstract *The present article describes the development of the initial version of the Brazilian Care Management Information System for the Home Care Network (SI GESCAD). This system was created to enhance comprehensive care, care coordination and the continuity of care provided to the patients, family and caretakers of the Home Care (HC) program. We also present a reflection on the contributions, limitations and possibilities of the SI GESCAD within the scope of the Home Care Network of the Brazilian Unified Health System (RAS-AD). This was a study on technology production based on a multi-method protocol. It discussed software engineering and human-computer interaction (HCI) based on user-centered design, as well as evolutionary and interactive software process (prototyping and spiral). A functional prototype of the GESCAD was finalized, which allowed for the management of HC to take into consideration the patient's social context, family and caretakers. The system also proved to help in the management of activities of daily living (ADLs), clinical care and the monitoring of variables associated with type 2 HC. The SI GESCAD allowed for a more horizontal work process for HC teams at the RAS-AD/SUS level of care, with positive repercussions on care coordination and continuity of care.*

Key words *Home Care, Information System, Work Process in Health, Care, Information Technology*

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Introduction

The development of health information systems (HIS) that support the actions of professionals is an emerging theme in the Brazilian Unified Health System (SUS), as the care coordination of the Healthcare Network (RAS) requires interaction among different professionals. Information systems (IS) are defined as a set of inter-related components that collect, process, store and distribute information relevant to decision-making processes at the managerial, operational or strategic level, taking into account the plurality of the organizations and individuals involved in the process. The field of study of comprehensive IS includes some basic components of information technology, such as: technique, development and product use and management[1-4].

Several studies have shown that despite the vast growth of computer sciences in contemporary society, the adoption of information and communication technologies and IS by health professionals in care management is a process still under construction in developed and developing countries[4-5]. Regarding the discussion on the production of knowledge on IS, some authors defend a greater inclusion of contextual and interpretative aspects involved in information management, object of IS, in an attempt to broaden the approach to social reality. Above all, these studies criticize the excessively pragmatic and positivistic nature of the investigations, as publications on the subject rarely contemplate the complexity of the reality, disputes, and relationships of power present in knowledge societies[6].

Regarding the possible impact of HIS in health care, review studies have shown a slight improvement of care quality due to the use of electronic patient records or electronic health records, which brings to light the complexity of the factors involved[7-9]. The electronic patient record system was developed specifically for health care services and includes information on patient identification, medication, prescriptions, records, lab tests results, and, in some cases, all health information recorded by professionals during each appointment. The electronic health record is a broader system, containing all of an individual's health information. It can be accessed electronically by professionals throughout a person's life span and extends to all situations in which a patient receives care. Ideally, the electronic health record should contribute in the sense of making an individual's information promptly available at all points of the health care system[10].

Within the SUS, the lack of knowledge and practice of IS for dealing with the contemporary complexity of the health-illness process is amply debated. The current discourse on HIS expresses the expectation that such systems contribute to improving the quality, effectiveness and efficiency of care, causing a positive impact on the social production of health care[11-13]. In this scenario, the Home Care Policy[14] created by SUS strengthens the perspective of the Home Care Network (RAS-AD) and foresees that professionals adopt technology for managing care. According to this document, HC is considered a substitutive or complementary modality to the already existing care services. It consists of a set of actions aimed at health promotion, prevention, treatment and rehabilitation provided in the home, with guaranteed continuity of care, integrated with the RAS-AD.

The importance of HIS for care coordination and continuity in primary health care is a recurring theme in literature reviews about HIS and that is also a high priority for the process of reorganizing the information policy of SUS[11-13,15-18]. Care coordination consists of articulating health services for a certain intervention so that, regardless of where such actions are provided, they have the same goals in mind. Operationally, the term translates into the continuity of user care within the health system, which becomes the guiding principle for all Home Care Network health actions and services[19].

In turn, care management, or the ambivalent care provided within the context of helping-power relationships established between subjects, capable of the emancipatory subversion of restrictive impositions on human freedoms, enhances the articulation of resources and of the actors involved in making such power relationships more democratic. Thus, the ontological, ecological and political conceptions present in care coordination and continuity are recovered, which are all requisites for care management[20].

The development of the Care Management Information System for the Home Care Network (SI GESCAD), object of the present study, was preceded by a study in two Basic Health Units in the city of Belo Horizonte, Brazil. The results of this investigation served as the basis for developing the SI GESCAD and are available online. In synthesis, the study presents: a) validation of clinical and social instruments with which health teams can approach patients, their family and caretakers; b) variables associated with change in type of HC so that health teams can monitor

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the patient's clinical, social and epidemiological conditions; c) a list of nursing diagnoses and interventions, according to the International Classification for Nursing Practice, based on the empirical data of HC users and the methodology recommended by the International Council of Nurses[21,22].

In light of the above, this article presents the development of the initial version of a health information system (HIC) for RAS-AD care management that supports the provision of care, care coordination and continuity of care for HC users, their families and caretakers by the HC teams working within the SUS. We adopted the hypothesis that in order for an IS that makes use of electronic patient records to allow for care management, it must be structured on the dimensions of anamnesis and clinical care, on ADLs and on the social and family context of HC patients. The objectives of the study were: 1) to describe the development of an initial version of the SI GESCAD, which aids in providing comprehensive care, care coordination and the continuity of care to patients, their family and caretakers in the HC program, and 2) to present a reflection on the contributions, limitations and possibilities of the SI GESCAD within the scope of the Home Care Network of the Brazilian Unified Health System (RAS-AD).

Methodology

This was a technology production study based on a multi-method protocol that analyzed the political (health policy), organizational (health services) and clinical (professional practice) levels that influence IT modeling. The multi-method approach provides a better understanding of the complex phenomena involved in developing and implementing electronic health records, necessary for constructing HIS for care management[23].

In the field of software engineering, the development of the initial version of SI GESCAD was anchored in evolutionary models of software process, namely, the prototyping and spiral models. The evolutionary spiral model combines the interactive nature of prototyping with the controlled and systematic aspects of the waterfall model. In this manner, the software is developed in a series of versions that are systematically perfected, in an interactive and incremental manner[24]. This methodology fits the procedural quality foreseen for the creation of GESCAD. The first phase of the project aimed to produce a completely functional prototype in order to verify its suitability to care coordination and the viability of implementing it within the context of the Brazilian public home care program, RAS-AD/SUS.

The software development was also based on practices recommended by the field of software engineering, such as the use of abstract and precise models for software specification, design, implementation and maintenance, with quality assurance assessments. More specifically, the agile software development method[25] was used, which is composed of the following phases: requirements analysis, specification (a precise description of the software that will be written using models), definition of the architecture and data model, implementation by prototyping and other actions comprised in this technique.

Software development followed the general activities of descriptive framework for most of software process models, namely: a) communication (requirements gathering); b) planning (work plan for software engineering); c) modeling/specification (precise description of the software that will be written using these models, in this case, Unified Modeling Language, or UML; d) construction (code, test); e) implementation (delivery and assessment) [23]. In order to establish a standard for the models generated in the system development process, UML was used[24-26].

In the communication and planning phases, we conducted the conceptual adjustment of the products created in the previous phase of the study: a) an instrument for approaching users, their families and caretakers; b) variables associated with type 2 HC; c) nursing diagnoses and interventions with HC users using terminology from the International Classification for Nursing Practice to create an electronic patient record aimed at care management.

In the city of Belo Horizonte and in the Federal District of Brazil, an exploratory study of the HC policy of SUS was conducted to examine the context of health services regarding IS development. Researchers used documentary study and participant observation to study the professional practices of family health teams, based on the political, organizational, and clinical dimensions contemplated in the multi-method approach[23]. Thus, doctors and nurses of two SUS family health teams, one in Belo Horizonte and the other in the Federal District, assessed the validated instruments in their HC practice in terms of their size, pertinence and potential for continuity of care for RAS-AD patients. Subsequently, participants were interviewed as to their assessment of

the instrument and suggestions for the SI GESCAD.

Furthermore, the previous research had validated these questionnaires and also verified their pertinence to the daily routine of the investigated basic health units[21]. In this investigation that served as the empirical basis for the GESCAD, conducted from 2008 to 2010, a cross-sectional study was conducted in two basic health units in Belo Horizonte with all HC users (n = 114) (UBS) de Belo Horizonte, within the scope of the family health teams. The study assessed the anamnesis, clinical care, ADL and the users and caretakers' social and family context. Next, the risk factors associated with change in type of HC and that influence RAS-AD care management were identified using multivariate logistic regression analysis for selecting (stepwise regression) significant variables[22].

System requirements analysis was conducted using prototyping so as to strengthen the interactive processes expected in the development of health information systems[24-28]. Paper models of each of SI GESCAD screen were created for the discussion of system's modules, functionality, steps and reports. For 12 months, evaluation sessions were conducted with the contracted IT company, the research team, health secretariat workers of the Federal District (SES-DF) and HC team professionals. In these evaluation sessions of the GESCAD "display-prototype", many modification and adjustments were made until a consensual version was reached. With each concluded phase, system modeling advanced with the use of UML and by defining each respective use case. During the construction phase, the IT company proceeded to program the system, having regular discussions with the research team.

In the implementation phase, when the final product was delivered, the suitability and functionality of the GESCAD was tested in undergraduate courses at the University of Brasilia, the Higher School of Health Sciences/Fepecs/SES-DF. The product was also tested in the activities of the Pro-Saúde II (a program for restructuring professional health training), University of Brasilia, in the Home Care Nucleus of the regional public hospital of the city of Paranoá (NAD/HRPa), Federal District. After these experiments, the system was assessed as to its contribution to organizing RAS-AD services. To this end, a seminar was organized on GESCAD in November 2012 with the presence of approximately one hundred people, among them SES-DF health professionals, technicians and managers, researchers and debaters from the University of Brasilia, the Federal University of Minas Gerais and the Federal University of Paraíba, guests, National Home Care Coordination managers from the Ministry of Health, SUS-DF undergraduate and graduate students and one family health team from SUS-BH.

At the seminar, the initial version of the SI GESCAD was presented, as well as the implementation experiments in Belo Horzionte and the tests run in the reality of NAD/HRPa services. Subsequently, debates took place on the potentials and limitations of IS for care management in the context of RAS-AD/SUS. One last assessment of the SI GESCAD took place to discuss the accessibility and usability of the system[29,30].

The study was approved by the research ethics committees of the Federal University of Minas Gerais (UFMG), the Belo Horizonte Municipal Secretariat of Health, and the Foundation for Research and Teaching of the Federal District (Fepecs/SES-DF).

Results

Conception of the GESCAD: communication and planning

The communication and planning phases of the software development process, which consisted of adjusting the printed GESCAD instruments to the technological environment, resulted in a more comprehensive program that could be used by all RAS-AD/SUS home care teams. Thus, continuity of care to RAS-AD/SUS patients using the SI GESCAD is ensured by basic care teams, multiprofessional HC teams and multiprofessional support teams, as provided for in the current national policy for HC (Ordinance 963 of the Brazilian Ministry of Health, May 27 2013). Electronic health records contain an administrative module for the initial registration of health teams and units by level of care, region, municipality and state. Another module allows for the care of HC users to take into account their families and caretakers, using an electronic patient chart based on the clinical, social and epidemiological dimensions as later described.

The management of HC user care is conducted by monitoring significant variables associated with the HC modality provided to the patient (type of HC), facilitated by the registration tools, the electronic patient record, visit schedules, standardization of nursing care, and the teams'

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therapeutic conducts. These variables of RAS-AD care management indicate clinical, social, and family risks factors and the independence level of HC users, as well as the possibility of decline in a given diagnosed situation. The system allows professionals to extract three types of reports: managerial; b) monitoring and assessment; and c) clinical management and continuity of care.

Modeling

In consonance with the planning and communication phases, requirements gathering for the GESCAD took into account the needs of health professionals, managers and professors – primary or secondary IS users. Chart 1 summarizes the system's main functional requirements that originated from respective use cases (Figure 1).

Requirement definitions (Chart 1) and GESCAD Use Cases (Figure 1) were based on the assessment conducted by Family Health Teams in Belo Horizonte and the Federal District. After testing the printed versions of the instrument, which allows for a more comprehensive approach to HC in the respective areas within the scope of the basic health units, medical and nursing professionals reported that: a) the items in the Diagnostic Phase of the instrument allowed for a more comprehensive view of the reality, family relationships, caretakers and social context of HC patients; b) the instrument's care protocol was suitable for the work routine and principles of primary health care; c) all of the items in the instrument should be maintained in the SI GESCAD, even if that means that the first HC visit require more time; d) standardizing nursing care enhances the quality of HC and better defines the role of nurses; and 3) there is a real need for technology that allows for continuity of care for HC users assisted by RAS-AD health teams.

Construction and implementation

The GESCAD used Visual Studio Express 2010 and Sql Management Studio Express 2008 programs, ASP.NET C#, HTML, CSS, and JavaScript programming languages, and the Sql Server Express 2008 data bank. To begin using the system, health professionals must register HC users by inserting their information. Subsequently, the HC team doctor or nurse conducts the Diagnostic Phase of the registered patient, according to the GESCAD care protocol, which is based on three dimensions: a) patient anamnesis and clinical examination; b) activities of daily living (ADL) and the Braden Scale; and c) the social and family context of patients and caretakers.

Once professionals conduct the initial interview with patients, family and caretakers, the system classifies the patient according to type of HC and calculates the values of risk variables for change in the existing situation, which corresponds to the "Care Management" phase. In subsequent visits, professionals will only use the indicator panel for care management and the text fields for care plans, streamlining the visitation process. For nurses to standardize HC patient care, they must select nursing diagnoses and interventions according to the International Classifications for Nursing Practice, catalogued by basic human need. Other functions of the GESCAD include extracting reports, rescheduling visits and migrating HC users to other health teams, all important tools for ensuring continuity of care in RAS-AD.

The participants of the GESCAD assessment seminars emphasized the advances and limitations of IS for coordinating care within the scope of RAS, based on the reported experiences. Some of the system's strong points related to care management within the teams' work processes included: a) the electronic health record is suitable for the organization of HC services within the RAS; b) using the system allows for a more comprehensive clinical practice and a more contextual view on behalf of health professionals[31]; c) the table with care management variables makes it easier for HC teams to conduct health surveillance, especially in the presence of warning signs; d) the GESCAD is viable for use in teaching, research and extension programs and SUS health services; e) the IS provides nurses with the tools to standardize their practice and qualify HC; and f) the system enhances exchange of information between RAS-AD professionals and health teams and the different levels of SUS care.

Participants reported the following limitations which should be perfected: a) the GESCAD and electronic patient record system currently used by the secretariats of health must be interoperable in order to facilitate its implementation and adherence by health professionals; b) the "Care Management" phase needs to accommodate all health professionals that compose multiprofessional teams; c) the system's usability, particularly with respect to the "Care Mangament" tab, has some defects and must be better assessed; c) some navigation, interaction and graphic development displays need to be honed; and d) the tool for standardizing nursing care

Chart 1. List of the main functional requirements for SI GESCAD.

Scope	Functional requirements
Administrative module	- To register Health Unit (HU) data. - To register Health Team (HT) data. - To register the data of health professionals. - To register the login and password according to "health professional" or "system administrator". - To link HU and HT by level of care within the same municipality. - To add HU and HT by state municipality.
Care provided to HC patients, their family and caretakers	- To register HC patients: to record patient identification data, including full name, date of birth, gender, CPF (individual taxpayer number), SUS card no., and full address. - To record care provided to patients, their families and caretakers: the system must record all the information inserted according to the Diagnosis Phase protocol. - To calculate the KATZ index and Braden Scale score: to generate patient KATZ index and value and risk for pressure ulcer, based on the values inserted in the IS and rules of the IS. - To calculate patients' type of HC: to classify patients as HC 1, HC 2 or HC 3 based on the data inserted in the IS and rules of the IS. - To emit warnings on risk factors so that type of HC can be modified on the "Management Care" display: to emit a warning regarding risk variables so that type of HC on the "Management Care" display, according to the data inserted in the IS and rules of the IS. - To allow for changes in the patient's situation using the variables selected in the "Management Care" display. - To select nursing diagnoses and interventions listed by the IS by human need. - To update patient assessments on the SI GESCAD patient care record by date and health professional. - To register HC patient care history on the electronic patient record by date and health professional. - Generate a printed version of the electronic patient record and standardized nursing care for HC users by date of visitation and health professional. - To allow for user migration between RAS health teams. - To schedule team visits to HC users. - To allow health teams to reschedule visits.
Reports module	- To generate managerial reports: extract reports from HU, HT and professionals registered by level of care, municipality and state. - To generate monitoring and assessment reports: To generate a list of users by type of HC, by teams and level of care. To display level of adherence by nurses to standardized nursing care. - To generate clinical management and continuity of care: To print versions of electronic records by dimension, conduct history and standardized nursing care. To extract user data using an Excel spreadsheet.

needs to interact more with the clinical judgment of nursing professionals.

Discussion

The multiple forms of organizing HC services in Brazil, which only recently received its own public policy, influence health practices and, consequently, the relationship of professionals with information technology[5,23]. This intricate scenario in which the GESCAD is to be developed, inscribed in the reality of the country, compromises, in part, the success of engineering a user-centered IS, as recommended in the literature[23-30]. To this regard, literature review studies have shown that the following factors influence the success of HIS development and implementation: the availability of systems within organizations; the involvement of users in developing

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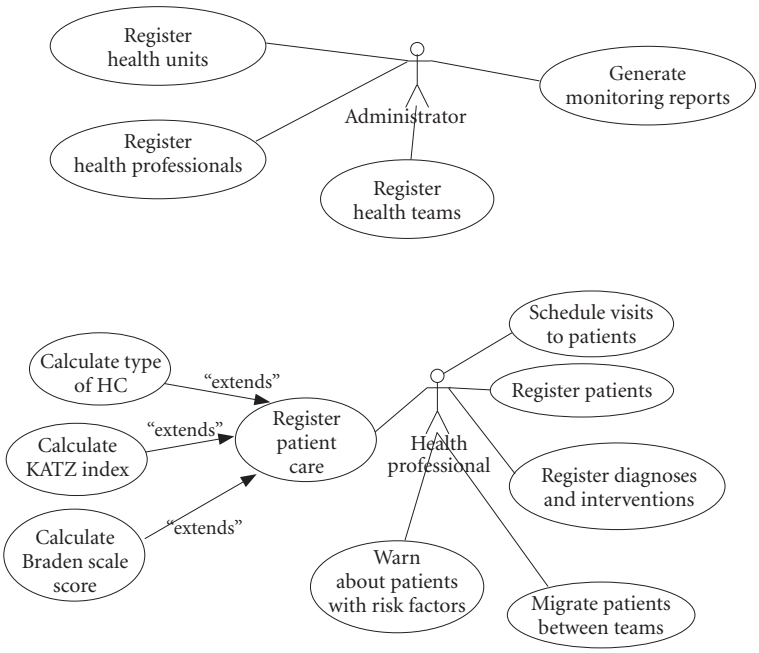

Figure 1. Example of a UML diagram (Use Case) of SI GESCAD modules.

the systems; the support provided by HIS for decision-making processes based on reference practices and a contextual approach[7-9]. With regards to this discussion, scientific production in the field of e-Health, a field of knowledge centered on the wide range of applications of IT to support health management and care practice, has investigated the multiple and complex aspects involved in applying IT to health care[32].

On the other hand, there are great possibilities for change in health practices that can take place in the inter-subjective encounter between teams and service users in the home. Such changes can result from the tension that surges due to the many different types of care – those suggested by professionals and those that are part of the family's particular therapeutic plan[32-34]. Thus, in light of the complexity of social, clinical and epidemiological problems that health teams face in HC, the need for work instruments, technology and care conceptions for working in this reality persists[18-22].

Accordingly, the GESCAD, which is based on a social, epistemic and ontological understanding of care, proved to be a technological instrument that can help structure health work processes. Furthermore, it also helped provide a more comprehensive view of individuals who need care and the situation in which they find themselves. This perspective was confirmed by the results of this study, which indicated that the system allows for more horizontal work processes in RAS-AD/SUS teams.

In consonance with the literature, the development of the GESCAD system is part of the strategies used to strengthen care coordination and continuity within health care systems, a process reinforced by the presence of information and communication technology. In this sense, systematic reviews have indicated four areas in which health system reform processes can enhance care coordination[7-9]: a) the implementation of necessary changes in primary health care for meeting the demands created by chronic illnesses; b) the review of standards for allocating resources to the ambulatory sector; c) lack of integration between levels of care and care providers due to barriers which interfere with patient flow within the health system; and d) the honing and exchange of user information made possible by information and communication technology. Another study emphasized the role of electronic patient records and electronic health records in care coordination, especially due to the ease in

exchanging information among teams, organizing records and monitoring the clinical evolution of patients[15].

The functional specificities of the GESCAD, as experienced and reported by the professionals, managers, researchers, professors and undergraduate students who assessed the system, are in accordance with the successes and challenges inherent to IS development identified in the literature. Studies on the contribution of electronic health records to care coordination have identified the characteristics that facilitate or hinder continuity of care in professional practice. Among the positive and desirable requirements for electronic health records in care coordination, we mention: patient rosters; appointment scheduling; summary displays; patient history and patient care history, a summary of the patient's condition; and reminders and warnings about hazardous situations. On the other hand, the most common aspects that interfere with care coordination are deficiencies in the functions listed above, excessive information, and lack of interoperability[16].

The results of this study show that SI GESCAD's contribution to care coordination and continuity for HC users, families and caretakers in RAS-AD is centered primarily on the potential of such technology in terms of organizing HC services, managing information exchange among teams, incorporating a comprehensive approach, and the practice of health surveillance by professionals at different levels of SUS care. We emphasize that the baseline research that gave way to the GESCAD[21,22], inserted in the reality of Family Health Teams, added value to and provided critique for the developed prototype. On the other hand, further studies focusing on the multiprofessional teams of the current HC/SUS policy as users of the system would help address the limitations of the GESCAD interface and usability, in particular those related to the "Care Management" phase. We emphasize that a factor that hinders the adherence of health professionals to the GESCAD is the lack of interoperability between it and the electronic patient record system currently implemented in the SUS health secretariats. The same is true for GESCAD and the current e-SUS Basic Care system used by the Ministry of Health. In either case, this situation represents a limitation for implementing and testing GESCAD.

Attaining such communication between two or more systems, given the heterogeneity of the currently existing health information systems used by Brazilian Unified Health System, is an opportune goal that would optimize the necessary tools for the functioning of the health team network, especially in the scope of care managment[11-13]. To deal with this issue, the second phase of research received financial support so that the system's initial version can be perfected.

Conclusion

The SI GESCAD allowed for a more horizontal work process for HC teams at the RAS-AD/SUS level of care, with positive effects on care coordination and continuity. Care management provided by this system was based on the patients' and caretakers' social and family context, ADL, clinical care and monitoring of variables most significantly associated with Type 2 HC. Limitations include the need for heuristic assessments and for improving system usability by all RAS-AD multiprofessional teams. The system must also advance in terms of its interoperability with electronic health records in order for more professionals to adhere to its implementation as a care management technology within SUS.

Collaboration

MRGM Pires contributed to the project conception, data analysis and interpretation, and drafting of the manuscript. LBD Gottems, JE Vasconcelos Filho, KL Silva and R Gamarski critically reviewed the article and added intellectual content to the final version for publication.

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