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Iztok Bitene
University of Maribor

Robert Leskovar
University of Maribor

Vladislav Rajkovic
University of Maribor

Mojca Bernik
University of Maribor

Olga Susteric
University of Ljubljana

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Iztok Bitenc, Robert Leskovar,
Vladislav Rajkovič, Mojca Bernik
Univ. of Maribor, Faculty of Organizational Sciences,
Kidričeva 55a, 4000 Kranj, Slovenia

Olga Šušteršič
Univ. of Ljubljana University College of Health Care,
Poljanska 26a, 1000 Ljubljana, Slovenia

Abstract–The paper presents results of a critical analysis of an information system (IS) for community nursing (CN) which has been developed to improve health care in Slovenia. The goal of IS is to support CN practice and to encourage research and development in the field. The developed IS will: increase work efficiency, introduce process-oriented nursing doctrine, support integrated treatment of the subjects and enable data communication. In the paper main stages of IS development are shown with detailed explanation of functional model, data model, user interface, testing phase and implementation. Critical analysis is based on SWOT techique.

I. Introduction

CN is defined as a special form of health care that ensures an active health and social care of clients (individuals, families and communities) that are, due to their biological features or a particular disease, more exposed to harmful effects from the environment. Community nurse helps clients to perform better daily living activities in various health conditions from birth to death. The role of the community nurse is to support activities in primary health care, prevention and health education (for example Salvage [11]). According to the Resolution WHA49.1 (World Health Assembly) »nursing/midwifery service development is an integral part of health development. To maximize the contribution of nurses and midwives to the achievements in the field of health country-specific approach must be adopted. Active involvement of nurses at all levels of the health care system, together with the recipients of health care, policymakers, the public and private sectors, representatives of professional associations and educational institutions, and those who have responsibility for social and economic development must be assured«.

The goal of an IS for CN is not only to help in performing the routine work in practice. The use of information tools is also a challenge and opportunity for new ideas and solutions leading to a higher level of quality of work and life. The interdisciplinary approach in development enables co-operation of various experts from different institutions. The IS will move the community nurse's work away from a task-oriented approach to a more client-oriented one using problem-solving strategy covering the following major steps: identification of needs for nursing care, decisions on nursing interventions and outcome evaluation (Šušteršič, Rajkovič [12]).

The IS was developed in the frame of EU project INCO Copernicus: Co-operative Research in Information Infrastructure. The project linked the efforts of several public and private research / government / industry partners: University of Maribor, Faculty of Organizational Sciences, University of Ljubljana, University College of Health Care, INFONET company, Health Centre Ljubljana-Bežigrad, Health Centre Radovljica and Danish Institute for Health and Nursing Research. Summary of the project is available on Internet page (http://lopes1.fov.uni-mb.si/patro/index.htm [3]). In the process of IS development prototyping approach with the on-line verification in practice was used. This methodology is suggested in the literature (for example Martin [7]). Such approach does not only ensure greater functional adequacy of the system; it also stimulates the user, i.e. the community nurses, to exhibit a higher degree of creativity. The program is written in Borland Delphi and runs under Microsoft Windows. Users' manual with program documentation is already available. IS supports the following main functions of CN process: identification of patients' needs, CN planning, treatment and evaluation. Client treatment includes follow-up of daily living activities, nursing diagnoses, nursing interventions (actions) and evaluation of outcomes. Program is designed to be used on local area networks in health centers as a client-server application. For the nurse it offers possibility to use a portable PC (for example Toshiba Libretto) on home visits, where it is used for updating the client's record immediately on site.

In the paper the function of CN will be described, followed by the data model and user interface description. Special emphasis will be laid on implementation and testing of the proposed prototype.

II. Development Of CN IS

A. FUNCTIONAL MODEL

The process of CN enables systematical, individualized and holistic approach in solving nursing issues relevant to healthy or sick client, family and community. There are four phases: a) need assessment which covers nursing problem and making of diagnosis, b) goal and intervention planning, c) performing nursing interventions and d) evaluation of outcome (Ellis, [1]). In figure 1 the data-flow diagram shows the main system functions and data flows. Further functional

decomposition is reported in the proposed project documentation (Jereb [4]). The need assessment function consists of five subfunctions: information gathering, interpreting, recognizing, ranking and checking. The planning gives detailed CN plan, which includes decision-making, what to do and how to do. The subprocess of planning are: joint goal settings, selecting nursing interventions, preliminary contact with client in order to get confirmation of the plan, dissemination of the CN plan to other relevant recipients (co-workers, relatives). Implementation of planned interventions includes nursing and technical procedures. These procedures are adjusted according to the current state of the client and unpredictable developments. Performed interventions are recorded in CN plan. Evaluation is the most important phase in CN. It enables process improvement for the benefit of the client and cost effective treatment. Feedback information can contribute to better need assessment.

The analysis of the current practice in two health centers was performed. It was determined that current practice differs among health centers and that practice deviates from proposed theoretical education process. Duplicated, incomplete and inaccurate paper documentation on clients is kept on various locations. Several problems related to data gathering, data updating and data deletion were identified. Personal data security problem was generally inadequately treated. Scheduling of the CN process, planning and evaluation were neglected either because of shortage of time or because of inaccessibility of relevant data. On the other hand the administrative tasks proposed by theoretical model would significantly decrease the time that a nurse devotes to a client. The »unified nursing language« described in (Mortensen [9], Wake et al. [14], Mortensen [10]) and proposed by ICNP (International Classification of Nursing Practice) is hard to use without computer support. Extensiveness of the language on one side and semantic deficiency on the other side are identified as serious problems. The conclusions made by system analysts were not black/white (Šušteršič et al. [13]). It was decided to design open-ended system, to implement theoretical model where it is reasonable, and to support good practice where necessary.

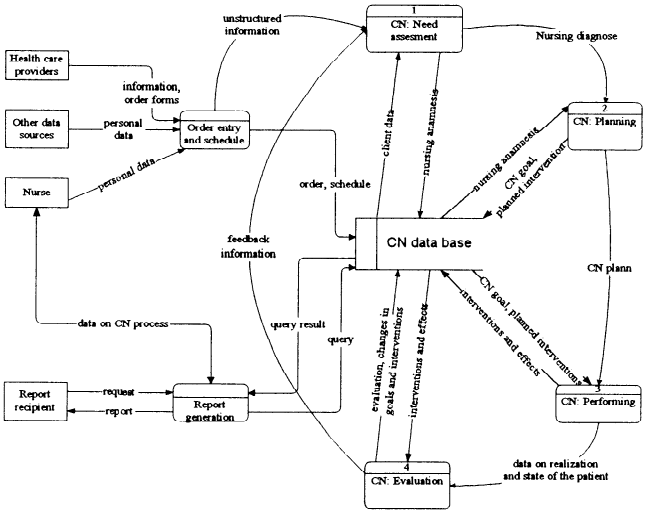


Figure 1. System diagram of CN process.

B. *DATA MODEL*

Data model was developed gradually during the research project. The first preliminary models were more medically oriented (for example Milavec et al [8]) and proposed mainly logical-semantic approach (Šušteršič, Rajkovič [12]). The later one included more or less complete data support for CN. Figure 2 presents the core of the current data model, which is described in Leskovar et al [6]. Complete data model includes more than 30 relational tables and more than 50 tables of codes.

The most important relational tables are *Client*, *Family*, *Community* and *Nurse*. Each *Family* can include many Clients; each family member is a potential *Client*. The new *Order* issued by *Order Issuer* triggers one or more *CN Processes*. Each *Process* corresponds to one of the states of the *Client* (for example newborn, child, teenager, adult, elderly person). The *Process* triggers *Visit*. Each *Visit* is scheduled by *Calendar*. The *Process* links different states of the same person while *Visit* links different activities during the visit. *Properties* are measured and each property has its own set of agreed values (*Domain*). *Instances of CN diagnoses* are confirmed during the visit. *Instances of CN interventions* are executed during the visit. Table *Property* stores all nursing anamneses. Additional classification of properties enables testing various coding schemes (for example complete or reduced ICNP, user proposed properties etc.). Tables *Insurance Company* and Instance of *Other intervention* will serve to demonstrate the financial aspect of CN.

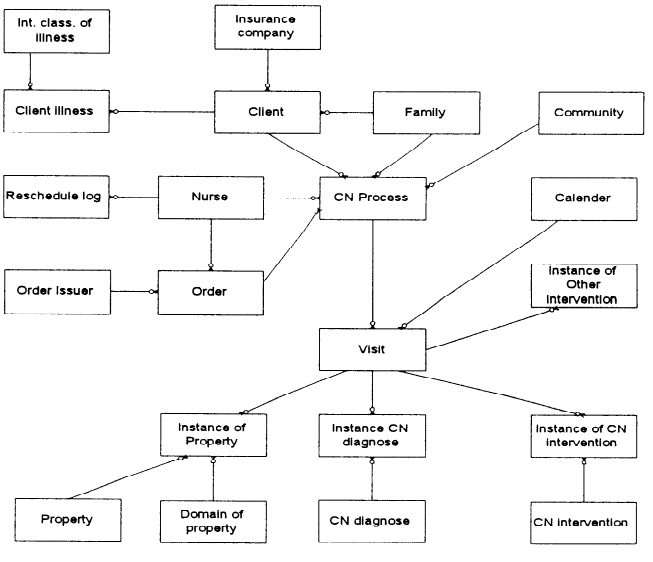


Figure 2. The core of CN data model.

C. USER INTERFACE

Borland Delphi was the chosen implementation tool. The application was designed as multiple document interface (MDI). Main window controls one or more child windows. Standard Windows entry/transition controls are used (drop down menus, combo boxes, ALT+character, toolbars etc.). The figure 3 shows the main window of application.

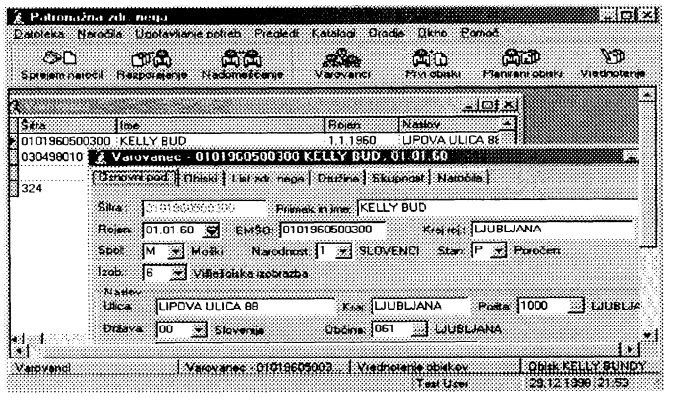


Figure 3. Main window of CN IS with four child windows (two shown).

After successful authorization, the application permits the user to perform granted functions. Three classes of users can simultaneously use the program: Administrator, Head Nurse and Nurse. The user interface kept a significant degree of similarity with theoretical model of community nursing described in chapter 2.1. Report section of the application is opened for new tools such as statistical package or expert system.

D. TESTING

The most important software assessment criteria are usability (time to learn), functionality (support for operational, administrative, research and educational purposes), maintenance (time to implement change) and reliability (number of errors per time interval, number of crashes per time interval, time to repair error). Black box testing at users' locations were performed (Leskovar et al. [5]). The learning curves of users were satisfactory. Users spent approximately 20 hours to become aware of the functionality and control mechanisms of the program. Embedded classification of the nursing phenomena took much more time to learn. Suggestions to tested functions of IS were collected and easily implemented. Acceptance test showed satisfactory results from nurses and clients.

E. IMPLEMENTATION

The information system architecture is schematically presented in figure 4. Servers in different municipals are connected via routers and public or private network. Alternatively, fast modems can be used. It is expected that the

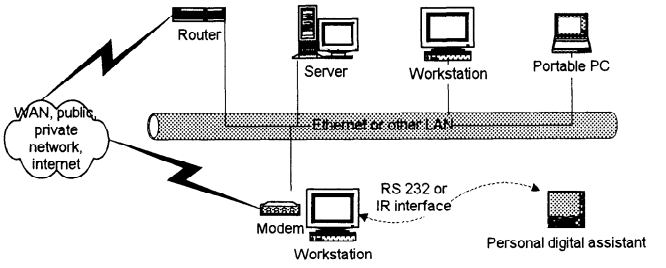


Figure 4. Information system architecture for CN

link between servers will support e-mail and client migration mainly. The proposed minimum configuration of the server is: processor speed 233MHz, memory 64MB, disk capacity 4Gb, DAT backup unit 4/8Gb, Windows NT operation system and Access/Paradox/Oracle/MS SQL database system. Workstations and portable PCs are Windows 95/98 based systems.

The communication between server and client is enabled via LAN preferably Ethernet. Portable PCs and personal digital assistants without network interface card will receive and send data through RS 232 or infrared interface. Personal digital assistants require data conversion from chosen database format to ASCII and vice versa. Preliminary tests with Apple Newton PDA and cable showed relatively fast conversion and transmission but at present too complicated for target users (nurses).

III. CRITICAL ANALYSIS OF IS

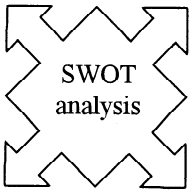
SWOT analysis was chosen as a tool for the analysis. It provides a framework for identifying issues that have the most impact on the situation. Significant strengths, weaknesses, opportunities, and threats that characterize the situation can be found. The results in the case of community nursing IS are presented in figure 5.

Strengths: close linkage between IS and process approach to CN is recognized as an important strength. CN IS is characterized by unified process approach. Data in our IS are therefore comparable with electronic patient record from other sources. Community nurses not only work with patients but also with their families and other communities, so support for these activities is included in IS. As a result we got large amount of well-structured data that enables easy overseeing of daily workflow for each nurse and to produce quality reports and documentation. Nursing anamnesis are based on daily activities (Henderson [2]) and serve as a checklist what patient properties should also be examined.

Weaknesses: in most cases of practical nursing a process approach is implemented only partially. Increased data entry also increases workload of a nurse. Testing phase revealed also a concern of some patients that nurses will pay more attention to the computer instead to them. This issue will become even more important with nurses that lack on computer literacy/skills. Another problem is accessibility of information and communication technology (ICT). Any up-

STRENGTHS
Integrated approach to organization of CN
Unified process approach
Electronic patient record
Treatment of family, community and patient
Better survey of work done
Better connection among finance, statistics and CN
Daily activities serve as a reminder/check list
Better documentation
Network and portable ICT

WEAKNESES
In practice a process approach is fragmented
Extension of work is enlarged
Poor computer literacy
(Un)accessibility of ICT resources
More rigorous supervision of nurse's activities
Financial and statistical part not fully implemented
Focus of attention shifts from patient to ICT



OPPORTUNITIES
Computerization of health care
Holistic patient/client treatment
Information picture/profile and feedback information
ICNP and nursing as a whole
Usage in education of community nurses
R&D in health care
Partial automation of nursing diagnoses and interventions
Evaluation and quality management

THREATS
Existent standards in CN
State of medical informatics
ICT and IS for CN are not a substitute for creative nurse and/or nursing process

Figure 5: SWOT analysis of CN IS

to-date desktop computer could be used as a server or workstation however in the field-work only portable computers can be used and they are priced double compared to an adequate desktop computer. When designing and implementing IS we focused primarily on nursing support. Financial and statistical reports were only analyzed to make sure no data were overlooked. At present these reports are implemented in software of other vendors. The last issue is also among strengths: with all the data about a patient and visits a very tight control over work of any nurse can be achieved. In the testing phase nurses expressed a concern of such kind of control being misused.

Opportunities: informatization of the nursing process could contribute to the development of informatics in the field of health care. Complete alpha version of ICNP is already built-in in presented IS. With all patients' data in computer a thorough approach to a patient can be afforded because computer will search relevant information and will produce information picture of him. This will also produce feedback information to nurses and other medical staff. An important part of IS is evaluation of patient's condition. Based on these data quality assurance with all its benefits can be introduced in process of nursing. Large amount of data on computer makes an excellent source for research and development in nursing. One of research topics could be an expert system for partial automation of nursing diagnoses and interventions. Because of its theoretically strong source and structure IS can be used in education of community nurses.

As **threats** we'd like to expose existing standards and legislation in CN. Currently they are in process of changes but IS isn't very compliant with the proposed ones that are based on paper processing. This issue clearly shows state of medical informatics where changing way of work involves much more effort then in other fields. At last we should stress that ICT and IS are not a replacement for a nurse because a computer is only a tool that can work with and offer existing knowledge. Only a human being can work in a new way, can be creative and can listen to the patient.

IV. Conclusion

The developed IS for community nursing is a practical software solution based on modern network, portable information and communication technology. The solution supports CN as a client/patient oriented process and can significantly contribute toward better quality of home health care and life of people in the need in general. This approach leads toward better evaluation and quality control in nursing encouraging further research and development in the field. Critical analysis of presented system showed many benefits from using process of CN as the core of IS structure. State-of-the-art approach to a client, family or community with a lot of data enables excellent reporting but also involves more work just to enter all the data. This can shift nurse's focus of attention from the patient to the computer. With small changes IS can be introduced into other fields of nursing. IS can serve as a tool for R&D in nursing, for evaluation and quality assurance and as an educational toll but only if current legislation and standards in CN allow that.

ACKNOWLEDGEMENT

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