Nursing informatics research

William Goossen argues that the increasing reliance on nursing informatics in recent years has highlighted a pressing need to ensure the approach has a sound scientific basis.

In recent years, developments in nursing informatics have been relentless. Based on technological inventions in computing and communications, several new applications have emerged in health care. While many applications make life easier for both patients and providers, some can create new problems.

In contrast to this technological revolution, areas such as patient information, patient care, documentation in nursing, and the adequate re-use of nursing data from electronic records (to aid evidence based practice and the management of nursing outcomes, for example) remain elusive. Perhaps nursing is focusing on gadgets rather than the real issues. If the problems in nursing information management are to be solved, we must develop appropriate technological solutions.

Nursing informatics needs a scientific base, in which a range of research methods can be applied (Goossen 1996). This article will explore the research questions, and the methods available, and discuss why and how they should be applied.

Nursing informatics as science
Graves and Corcoran argue that nursing informatics is a 'combination of computer science, information science and nursing science, designed to assist in the management and processing of nursing data, information and knowledge to support the practice of nursing and the delivery of nursing care' (Graves and Corcoran 1989).

The task of nursing informatics is to study the structuring and processing of nursing information to aid clinical decision-making. The aim is to build systems to support that process. To the extent to which the human processing of data, information and knowledge can be modelled, these processes can be represented in computer systems and the computer system programmed to mimic the process (Graves and Corcoran 1989).
Is nursing informatics research different?

During the International Nursing Informatics 2000 conference in Auckland, New Zealand, an expert lunch session was held. The aim was to create an informal environment in which up to 15 people could hold discussions with one or more experts. One subject was different approaches in nursing informatics research. The group agreed that nursing informatics researchers can adopt some methods from other disciplines. But the major difference between nursing informatics research and nursing research lies in the subject areas of study and the research problems to be addressed. Often these research problems have both a human and a technological aspect: the use of information and communication technology in a caring situation.

Nursing informatics also draws heavily on medical or health informatics, and the methodologies from these fields are also useful. In addition, the whole range of methodologies from the information sciences and from informatics can be applied. Finally, managerial and organisational issues are important.

Clearly, knowledge developed in one scientific arena can be applied to improve information and communication in nursing. But conducting research in this area can be complex. It is not only an engineering task: it requires an appropriate analysis of the problem, and the management of changing human systems.

In the next sections the possible research questions and methodologies will be discussed in more detail. It is important to note, however, that the intention is not to be complete, but rather to give an impression of possible approaches.

What are meaningful questions to address in nursing informatics research?

Basically nursing informatics should assist in solving problems in nursing information management. Simple questions here are: ‘What is the problem exactly?’ And: ‘Whose problem is it anyway?’ The soft systems theory (Checkland 1984) could be applied to find out what the problems are for whom, and to tackle them based on different models of reality. This approach is especially relevant because of the fact that any information system used in a caring environment, including a
computerised nursing record system or electronic patient record, represents a model of reality.

Based on Graves and Corcoran’s work (1989), an important question could be: ‘To what extent can nursing processing of data, information and knowledge be modelled and represented in computer systems?’ Then, we can identify an often-unlimited number of researchable problem definitions.

The framework for nursing informatics (Goossen 1996) allows several relevant research questions to be identified:

Figure 1. A framework for nursing informatics research

An initial question might be: ‘What data do we want to collect from patients or patient categories?’ Another might be: ‘What kind of information are patients looking for with respect of their health situation or needs for care?’ Another question could be: ‘What is the context data we need in addition to the initial data to get meaningful information out of it?’ This implies types and numbers of data, but also the interaction between the nurse and the patient, the nurse and the computer, the patient and the computer, and thus questions about the most appropriate designs of computer screens and software. What data manipulations need to be possible by the nurse in order to get the complete picture of the patient?

Further, what kind of knowledge does a nurse need when writing up a care plan? How much of the knowledge expressed in terminology

NURSE RESEARCHER VOLUME 8 NUMBER 2
and classification systems needs to be integrated in an electronic nursing record system? Will the use of health terminology complicate the understanding of the information by the patient?

How can we share data, information and knowledge with other disciplines? What evidence is available in the available knowledge?

What decisions does the nurse have to make, and how can the decision be modelled and supported? What is the influence of additional data or information on the screen? Does it improve or limit the quality of the decisions? Can we arrange the information in such a way that it supports the patient to take care of his or her own health?

The pragmatic aspect poses questions as what the effect of additional information is for understanding the health situation or for care interventions? To what extent is the quality of care improved by an electronic patient record? Can we determine patient outcomes that are counterbalanced for risk factors, multidisciplinary care, or setting variations? Does that prevent confounders of the results?

Can we integrate evidence-based guidelines and critical pathways to support all phases of the route of the patient through the health care systems? What kind of information management and processing is necessary to allow management to re-use the clinical data from the electronic records? How can we reuse information for research and policy making from electronic records? This would involve both the technical and research questions and the legal and consumer issues.

An important issue thus is: ‘Who in nursing needs what information at what time and place to perform which tasks?’ This is not only an information or a technological question, but also involves philosophical, social and organisation issues in health care. Of course this set of questions is not complete, the scope of research questions in nursing informatics is almost unlimited. It requires however different kinds of research approaches, which will be discussed in the next section.

Areas of interest for nursing informatics research
Epping (1997) has argued that although research in nursing informatics tends to be performed using quantitative, positivistic
Health informatics

approaches, such as programming and statistics, also qualitative and humanistic studies are necessary. Especially in the area of human communication, philosophic reflections about nursing informatics enable us to set the stage for further research and development.

In nursing informatics many early developments have not been researched but have been the result of trial and error. Learning from the pioneers was very important and in addition seeking consensus for approaches. Visionary papers in this area have been the identification of the nursing minimum data set (Werley et al 1991), and the accumulated learning and early research results written up in the paper: 'Next Generation nursing information systems' (Zielstorff et al 1993). Brennan et al (1992; Brennan 1995) have done additional pioneering work with consumers. Examples include the use of computer technology to support care givers of patients with Alzheimer’s, and using information elicited from the patient to influence the nurses’ priorities in care delivery.

The Priority Expert Panel on Nursing Informatics reported about the nursing informatics research agenda (NCNR 1993). This was the first attempt to set the stage for systematic nursing informatics research. These are still good resources for those wanting to start a research project.

During the last years the work on nursing terminology and classifications has gained more attention with respect to its consequences for electronic patient records (e.g. Goossen et al 1996; Ozbolt 2000).

Identified approaches for nursing informatics research

The next sections present an, albeit incomplete, overview of possible approaches for research in the area of nursing informatics. Goossen (1996) identified four main categories of research methodologies in the field of nursing informatics: communicative methods, analytical methods, engineering methods, and managerial methods. Examples in each category will be given.
Communicative methods
The first category includes communicative methods. These methods address the questions about motives and objectives for nursing and clinical information systems, and norms to adequately use them in the care environment without disturbing the relationship with patients and the care process.

Seen from Habermas’s philosophical perspective, information technology sometimes ‘intrudes’ into the life-world of the nurse-patient relationship, and can thus have a negative influence. A discourse could be one method to tackle this problem (Habermas 1981). Communicative acts are necessary to get a shared understanding and meaning between people. The discourse implies that the contribution of different participants in a project is equal, and that it is possible to set norms for the application of technology. For instance, the patient-nurse relationship is an example that is relevant in this domain. The nurse focuses on carefully understanding the needs of the patient. Also developing a shared vision on integrated care delivery is an example in this area.

In the ACTION project, the ethical justification of the use of telematic information technology in the care for frail elderly was investigated (Shewan et al 2000). This serves as a good example of this kind of research.

Analytical methods
The second category includes a wealth on analytical methods. Such methodologies focus on identifying and analysing information processing behaviours, knowledge management, and decision-making of nurses in several contexts in a rapidly and continuously changing health care system.

An emerging focus is on how the patient can become involved in their own care delivery and co-ordination and how their preferences can be used in this. Methods that could be applied in this area are observations, interviews, and document analysis, among others. Highlighting patients’ preferences for care, and the analysis of care planning documents is relevant in this context. However, it is important
not to limit oneself to only one approach, and certainly not to paper records analysis alone. It is known that many important data are missing in the paper records (Dick and Steen 1991). A multi-method approach would give the best results.

Ruland (1999) performed an important example of information analysis research. Based on the work by Brennan, described above, she elicited patient preferences for particular types of nursing care, gave that information to nurses for care planning and delivery, and found that the results of care were more satisfying for the patients.

Another approach in analysis concerns the analysis of nursing decision-making. Such approaches are called knowledge elicitation methods (McFarland 1995). The goals for applying such methods are to determine what the expert knows and how that knowledge is applied in problem solving and decision-making. After such an analysis this can be modelled and applied in information and communication technology. Further, evaluating the variety of existing information systems, applications and tools for applicability within nursing is an additional method.

How the user and computer interact has become a complete new field of science on its own. For health care this has specific concerns (for example, see Patel and Kushniruk 1997). Since then the importance of evaluating projects in nursing information system development and electronic patient records grows. This to justify the often enormous amounts of resources that have to be put in. Technology assessment is the general name for such evaluation, and this does not only include a cost-benefit analysis. Also cost-effectiveness and other approaches are known. One study in the EU series of medical informatics discusses different approaches in this area (Gennip and Van en Talmon 1995), although more recent material is also available. These research methods are important for the analysis of the effects of computerised systems on patient behaviour and nursing care.

Data mining has become an increasingly popular research method in nursing informatics. Now that some large databases offer patient and health related data the need is growing to get something meaningful from them. Two approaches exist in data mining: to explore the data without
An example is taking a hypothesised outcome variable (dependent variable), and use the data mining approach to identify risk factors for that condition. For example Abbott (2000) explored very large databases from long term facilities to find the risk factors that contributed to admission to acute care. Via data mining methods, both manual and statistical, she was able to identify 23 variables out of 1,098 that predicted admission to acute care. Such results can be used to prevent these situations.

The focus on outcome research supported by information technology is important. Holzemer and Reilly (1995) describe a methodology that can support research of outcomes for different levels: patients, providers and institutions. This kind of research would allow to further achieving a situation of evidence based nursing practice.

Increasingly, such outcome research is based on the development and use of critical pathways that structure the information and the care delivery for specific patient categories. The pathway describes the ideal route of the patient through the health system, can be developed multidisciplinary, and any variations from the pathway can be documented and analysed later to improve the care (Zielstorff et al 1993; Dickinson et al 1997).

Nursing minimum data sets allow the reuse of data from clinical records for other purposes (Werley et al 1991; Mortensen, 1997; Goossen 2000). Based on the documentation of patient data, described with unified terminology and/or nursing classifications, the data from clinical records can be aggregated and used for purposes as quality improvement, resource management, epidemiological research, and supporting policy making.

**Engineering methods**

The third category includes engineering methods. Traditionally, this has been the programming of systems, which with modern
Health informatics

technology becomes so easy that it looks that anybody can do it. Another aspect here is database development and management. Despite the ease of their development *per se*, this does not mean that amateurs make a system of high quality. Therefore it still needs high level knowledge and expertise to develop really good clinical and other systems.

One group of methods that has become increasingly important is modelling of information. Here we can differentiate between terminology and classification models and information models (Ozbolt 2000). Nursing informatics contributes to the development of standard nursing terminologies, classifications and taxonomies. An example for terminology includes the Read codes, which, with its 20,000 nursing terms and many thousands of consumer terms, has recently been incorporated in SNOMED (Systematized Nomenclature of Human and Veterinary Medicine). An example of a nursing classification is the International Classification for Nursing Practice (ICN 1999), but there are many more. Research and development in this area has increased in recent years.

Once the information requirements for a particular system have been determined, including the use of standard terminology, this needs to be modelled. Information modelling requires the use of formal methods, such as the Object Oriented Modelling approaches. One example of this is the Unified Modelling Language (UML) (Booch *et al* 1999). Such modelling simplifies reality by making explicit the objects for which information needs to be stored, the attributes and values of this information, and the relationships between objects. An example for nursing interventions has been presented by the Loose Canon Model group that used UML notations for a nursing intervention (Button *et al* 2000). These models help to keep sight on the very complex world of health care when it is represented in a computer system.

Then the development of actual systems is the ‘real’ engineering or manufacturing work. This can be twofold: 1. adapting, improving or customising existing applications and tools for a new environment, or 2. building a complete new system.
For the engineering work, standards are increasingly important. Contribution to standards development, applying standards when developing a system and evaluation of the usability of standards can be seen as methodologies, of importance to nursing informatics. Examples that are general standards for healthcare are Health Level 7 (HL 7), and the work of the European standards organisation (CEN). The Reference Information Model part of HL 7 is an interesting example of a system that offer seamless care to patients, across the traditional boarders of institutions.

Strachan (1996) identified that nurses in the UK considered a computerised multi-disciplinary, multi-agency patient record as the top priority system to support (hospital) nurses in the future. New frontiers are then coming up with the always-increasing push of technology. How should such multi-agency patient records be developed? In particular, the current wealth of small mobile computers that allow remote access to information for patients and nurses, or planning an appointment from a distance, and data-entry and decision support at the point of care, are challenging new projects in nursing informatics. Other examples of technological developments include the world wide web, which at this stage contributes to spreading health-related information to consumers, and in the near future, care and treatment supported via the internet can be expected.

One advantage of the object oriented approach in modelling and development is that parts of one program could be reused for others. For example, a patient administration program that keeps track of names, addresses, phone numbers and so on, could be used in the medical record, the nursing record, the radiology department, the outpatient clinic, and home visiting. It could also support patients’ access to their own records. Again, internet technology supports the distribution of both the information and the programs that support access to it. That way, the multi-agency patient record could be developed via the internet and with use of small mobile computers for remote access.

A very important group of methods that should always be applied, despite the actual technology used, is the specific technology that ensures confidentiality and privacy of patient data, and that protects the
Managerial methods
The fourth and final category includes managerial methods. Since the development and implementation of health care information systems involves humans, this also needs attention too. Methods that are valuable in this section include strategic planning and setting goals for appropriate information flows within institutions and the profession. Analysing ongoing and future changes in patients’ needs, health and nursing care for its impact on care delivery and information management is part of this as well. Management should encourage collaboration between nurses and patients and other health care providers and informatics professionals in the development of integrated health care information systems. Finally, applying project management methodologies is necessary to develop and implement systems in practice and facilitate the changes that go with it.

Conclusion
Nursing informatics is a relatively new discipline, and its research methodologies are still in a developmental phase. However, nursing informatics research should be done with the same scientific rigor as in any other discipline.

There are possibilities to do so. For instance, nursing informatics research can apply proven methodologies from biomedicine, medical informatics, nursing research, social sciences, computer science, information science, engineering and others. Further, a mix of both qualitative and quantitative approaches is usually necessary to get a complete picture of the area of interest. A comprehensive listing of possible approaches is given that can address the questions raised from the framework of nursing informatics, or from further study of the area. The number of questions and subjects that can be investigated in this area is vast and offers many challenges to nurse researchers with creative minds. The involvement of consumer groups and specific patient groups becomes increasingly important in these kinds of
developments.

Ultimately, we should ask whether nursing informatics contributes to people’s quality of life. The challenge for research and development in nursing informatics is to design and implement electronic patient records that allow the patient to become independent despite a chronic disease, and that support clinicians. The systems should allow for instance the systematic collection of patient demographics and characteristics, risk factors, problems/diagnoses, interventions planned and delivered, and whether these were based on guidelines or not, why there was a deviation from the guidelines and what the actual results for this patient were in comparison to his reference group thus to improve practice, by using and further establishing evidence.

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Health informatics


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