

Defining Information Requirements Using Holistic Models: Introduction to a Case Study

If older patients are to use the information superhighway, their ability and interest in using computers for clinical information exchange must be determined. Earlier discharge may alter the type of information that patients and families need to cope with recovery. The Gassert Model for Defining Information System Requirements for Nursing has been adapted to identify needed discharge information. Information requirements will be used to develop mobile computing technology for patients to use during recovery from cardiac surgery. Key words: *information requirements, mobile computing, models, nursing informatics*

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THE EMERGING health care environment forces patients to become more responsible for guiding their own care and allows fewer direct encounters with professional providers. Many propose that information technology will help patients increase needed autonomy in directing their care. The media's focus on the information superhighway has been phenomenal, with constant reports about potential benefits from using information technologies linked through health care enterprise networks and "telehealth" projects. Health care informatics specialists are predicting that the general population will use information technology to access on-line health information and services from home,¹ and there is increasing discussion about patient-focused informatics.

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One could predict that soon patients will be asked to access information from computerized programs preoperatively and postoperatively or to transmit data to health care providers to report concerns or problems for which they need help. Furthermore, smaller, lighter, and more convenient computing devices could facilitate clinical information exchange between patients and providers. These data could be used in turn to evaluate patients' outcomes and experiences with specific health events requiring intervention from health care providers.

BACKGROUND

Tremendous effort and cost have been focused on identifying and evaluating patient outcomes. A February 1995 report released by the American Nurses Association identified 21 outcome variables that are needed to judge the quality of nursing care given by health care agencies.² National data are unavailable for many of the needed variables, including discharge data. According to a Lewin-VHI report,² discharge data cover unscheduled physician visits, emergency department visits, readmissions, and knowledge of disease condition and care requirements. Care requirements include information about expected recovery from health events requiring intervention from professional providers.

Adding to the need for discharge outcome data is the fact that most patients, including older cardiac patients, are being discharged earlier after major surgery. More specifically, patients are being discharged 3 to 5 days after open heart surgery procedures (Burrows SG, Curran CR. Personal communications. 1995). These patients undergo thoracotomy and a major cardiac procedure,

are dependent on extracorporeal circulation during surgery, and are discharged just a few days later. Much care, including education about expected recovery at home, must be given in a short period of time to prepare these patients for early discharge.

With shorter hospital stays, cardiac nurses are concerned that patients may lack adequate discharge preparation, which may lead to unanswered questions about expected recovery, unscheduled physician or hospital visits, or emotional distress and frustration during the initial recovery period (Burrows SG. Personal communication. 1995). Anesthesia, pain medication, sleep deprivation, and fatigue often render patients unable to concentrate during teaching sessions. By the time they are interested in learning about expected recovery, they are at home. To compensate, patient education is being offered either before or after the patient is hospitalized for surgery, and some cardiac centers have initiated telephone follow-up programs (Curran CR. Personal communication. 1995). Patients are contacted at predetermined times, usually by nurses, to identify problems that may need medical and/or nursing intervention. Fewer nurses, larger patient populations to manage, and demands for increased productivity may limit the number of follow-up events for each patient.

In addition, earlier discharge after cardiac surgery may alter the types of information that patients and their families need to provide self-care at home during their recovery period, which is generally considered the first 4 to 6 weeks after discharge.^{3,4} Education materials for cardiac surgery patients generally have been prepared by professionals who are used to more traditional hospital stays of 5 to 7 days for routine car-

diac surgeries. Patients may need different kinds of information with earlier discharge, and existing information may be incomplete or inappropriate for patients recovering at home without having professional guidance immediately available.

SIGNIFICANCE

More complete data regarding outcomes of discharge planning for older cardiac surgery patients are essential to change interventions that would enhance their recovery experience. Mobile computing technology (MCT) could provide older cardiac surgery patients with a portable computer system to be used at home for accessing, collecting, and transmitting clinical information related to their recovery. Discharge data include the adequacy of discharge information available to patients during their recovery, the occurrence of unscheduled physician or emergency department visits, the incidence of readmission to acute care facilities, reported changes in quality of life and functional status during recovery, and patient satisfaction with the recovery process.

MCT includes cellular phones, notebook and subnotebook computers, and personal digital assistants. Mobile computing, particularly wireless technology, is gaining popularity in health care. Andrew⁵ states that all major communications and computing companies are developing MCT. The literature has focused primarily on providers' use of the technology⁶⁻⁹ rather than on patients' experiences with using computers during illness. Brennan¹⁰ and colleagues^{11,12} have studied the use of computer networks among individuals caring for patients with Alzheimer's disease. In similar studies,

Brennan and coworkers¹³ and Brennan and Ripich¹⁴ have examined the use of computers among patients with acquired immunodeficiency syndrome. Carl and Gribble¹⁵ describe patients' experiences with using information technology for provider-patient exchanges during major illness. There appear to be no studies that examine older cardiac surgery patients' use of computer technology. If older cardiac surgery patients are to use the information superhighway as a medium for clinical information exchange, their competency in and acceptance of information technology must be assessed.

RESEARCH FOCUS

This article reports an exploration of older cardiac surgery patients' experiences in using MCT, including their perception of the adequacy of available information about the disease, the surgical procedure, needed precautions, and expected recovery. The research is attempting to determine whether older cardiac surgery patients and their families will use MCT that is compact and capable of easily transmitting data and whether this technology can give providers additional information about older patients' recovery from cardiac surgery.

Considering the cost and lack of maturity of pen-based, voice-activated, and miniaturized computing technology,¹⁶ this study is using IBM ThinkPad 701C subnotebook computers with patients. This type of subnotebook provides a full-size keyboard and a 10.4-inch screen,¹⁷ both of which are important features for older patients. A TrackPoint III pointer, in addition to the keyboard, facilitates point-and-click data manipulation for patients who do not wish

to use a keyboard. At 4.5 lb, the ThinkPad 701C is within the weight-lifting limit for postoperative cardiac patients. The unit includes an infrared port for wireless data transfer and a data/fax modem for telephone transmission of discharge data. Use of a nickel-cadmium battery with a predicted life of 4 to 8 hours allows patients to use the computer several times a day and to recharge it when convenient for them.

SYSTEM MODELS

Two nursing informatics models guide the exploration of older cardiac surgery patients' use of MCT. Schwirian¹⁸ describes a pyramid-shaped model with the elements of information, user, and computer systems forming a triangular base of nursing informatics activity that reaches toward a goal. The user element includes the context in which users exist. The systems element includes both hardware and software components. Information is defined as that substance needed by the user. Although Schwirian¹⁸ proposed her model to support research in the field of nursing informatics, it can be applied to the domain of patient informatics. In the current study, older cardiac surgery patients are becoming users of computer systems, specifically ThinkPad mobile computers. Users' preparation for operating computers and their acceptance of MCT are being explored as part of the user element. Features of MCT that serve as either benefits or barriers to exchanging clinical information electronically are being identified. Discharge information needed, received, and transmitted by patients forms the information component of Schwirian's model. The goal of providing older cardiac surgery pa-

tients with MCT is to increase patient-provider communication that will positively affect outcomes related to patients' experiences with recovery from cardiac surgery.

The Gassert Model for Defining Information System Requirements for Nursing (MDISRN) also guides this research. It is being used to identify discharge information needed by patients and patient recovery information needed by providers. Its application embraces the performance of informatics activity included within the triangular base of nursing informatics activity defined by Schwirian.¹⁸

The MDISRN, formerly called the Model for Defining Nursing Information System Requirements, was developed using structured analysis techniques and was tested with 75 nurses who had actually made decisions about information systems. The MDISRN was found to be complete, useful, and clear.¹⁹⁻²³ Shaped as a pentagon, the MDISRN has five linked elements. In each model element, data are received as inputs, undergo specific processing, are considered in relation to influences or constraints, and result in unique outputs for that element. Collectively, the five model element outputs specify requirements for an information system (Figure 1).

Before any information system can be put to use by end users (patients or providers), a

Before any information system can be put to use, a series of requirements must be identified, the software must be programmed and tested, and the system must be implemented.

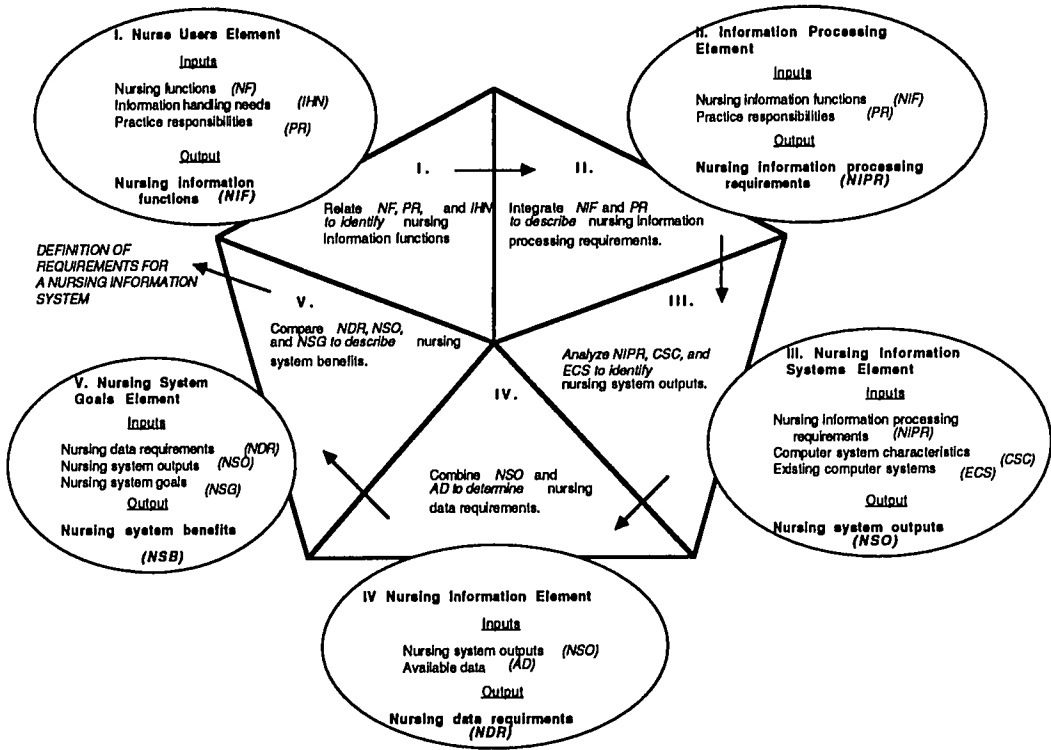


Figure 1. Gassert MDIRN. Copyright © 1987 Carole A. Gassert.

series of requirements must be identified, the software must be programmed and tested, and the system must be implemented. Traditionally, requirements are defined within a general systems development life cycle (SDLC) model. The SDLC model outlines an iterative process of specific steps needed to develop and operate an information system. The exact number and naming of steps in the SDLC vary from author to author.²⁴⁻²⁷

Ahituv and Neumann²⁴ include four major phases in their SDLC model. During the first step, definition, a preliminary analysis is used to identify organizational system re-

quirements, including goals; a feasibility study examines economic, technical, and organizational suitability of a proposed system; information analysis outlines functional specifications for an information system; and system design identifies information needed for task tables and used for programming. During the second, or programming, phase of the SDLC model, computer code is entered to develop programs, and procedures for using the information system are written. During the third, or implementation, phase, users are taught to use the system, files are created, and older or manual systems are converted to the new

information system. During the final, or operation, phase, the system is maintained and modified.

COMPARISON OF MODELS

Even though the SDLC model outlines steps or processes to be used with information system development, it does not address content areas or categories of information specific to health care that are needed for defining information system requirements or functional requirements. Recent changes in health care delivery have forced providers to consider a more interdisciplinary approach to naming, collecting, and sharing data and information. The value of discipline-specific information should not be ignored, however.²⁸ The nursing informatics models described earlier can point nurse analysts to specific content areas to be considered in defining requirements that will produce more holistic systems for patients and providers.

Traditional approaches to the process of defining system requirements have utilized a structured system analysis and design (SSAD) approach. Ross,²⁹ Ross and Schoman,³⁰ and DeMarco,³¹ among other authors, have described the processes in detail. In Ross and Schoman's³⁰ SSAD technique, a box is used to show an activity, process, or event (transaction) within a topic of interest. Each transaction is activated by inputs, outputs, constraints, and mechanisms. Inputs (things a transaction uses) enter the box from the left, outputs (things produced by the combination of inputs and constraints acting upon the transaction) exit from the right, constraints (anything that influences or modifies the trans-

action and its output, such as values or circumstances) press down on the box from above, and mechanisms (means of activating the transaction, such as models) press upward on the box.^{29,30}

Using an SSAD process adds specific configuration to the definition of system requirements, but end users often remain unable to decipher documents produced from the process and generally have limited involvement in the delineation of requirements. Hepworth and colleagues³² have expressed concern that an SSAD approach may support a more narrow view of information systems and have advocated the use of what they call a soft systems methodology (SSM). With SSM, once the activity is defined end users are encouraged to use a pictorial representation of the activity, environment, and information involved. Use of SSM has potential for helping patients define information needs and is an area of ongoing study.

The Gassert MDISRN was developed using SSAD techniques, a process that has been described elsewhere.¹⁹⁻²³ The advantage of using the Gassert MDISRN is that specific content (areas or categories of information needing definition) are included in the model (Figure 2). In addition, through testing the model has been determined to be complete, useful, and clear. Although the model was developed to address specifically nursing information needs, it should be useful in identifying patient information needs. Using the MDISRN goals, information handling needs, information processing requirements, information outputs, and needed data elements for discharge data will be identified in collaboration with nurses and patients at the clinical site. Fur-

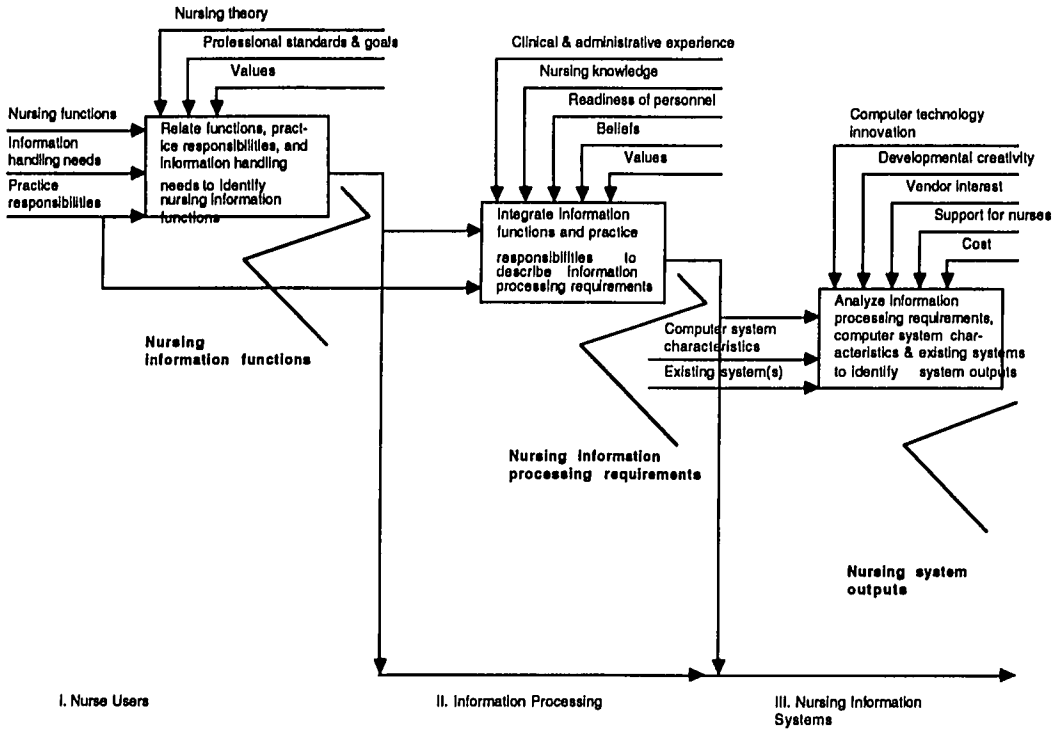


Figure 2 continues

ther evaluation by older cardiac surgery patients using MCT will confirm or refute the appropriateness of information requirements identified using the model.

APPLICATION OF THE MDISRN

Model elements, inputs, outputs, transactions, constraints, and mechanisms have been defined elsewhere.^{19,23} To apply the model in this study, model definitions were broadened to include both nursing and patient information requirements. Because this article presents ongoing research, examples of information requirements for only the first two elements have been included.

User element

The user element is defined by the processes of relating nursing functions, patient functions, practice responsibilities, and information handling needs to identify nursing and patient information functions.

- *Functions*—Nursing functions are defined as all activities performed by nurses in particular roles: as clinicians, in diagnosing and treating human response to actual or potential health problems or in helping clients perform health maintenance behaviors; as administrators, in managing care and resources; as researchers, in studying patients' use of computers; as educators,

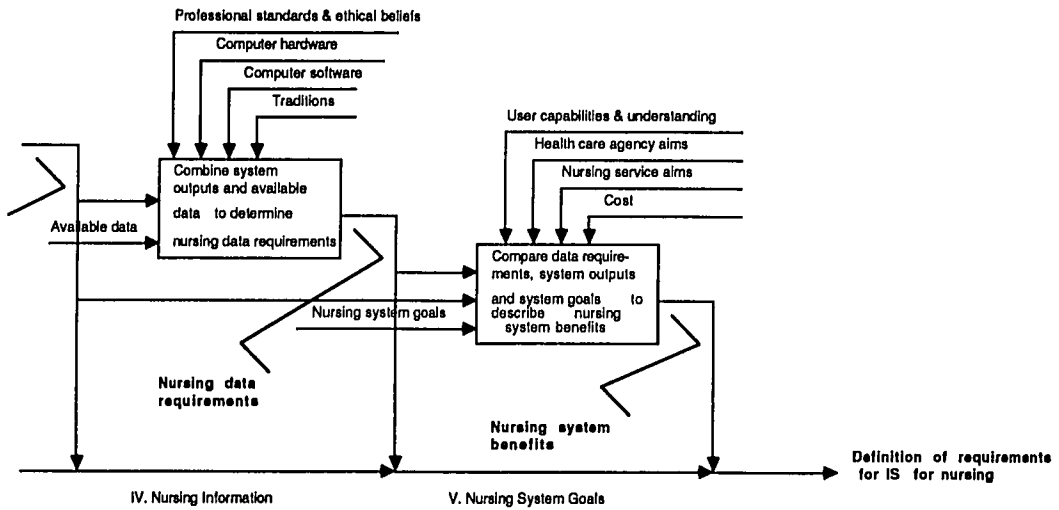


Figure 2. MDISRN.

in providing educational experiences for learners; and as informatics nurse specialists, in applying information technology to nursing. Patient functions need to be delineated.

- *Information handling needs*—Information handling needs include those documents containing data that must be read, recorded, or used for reporting by nurses or patients while performing their defined functions. Patient examples are bulletin board messages and discharge pamphlets. Nursing examples are patient functional status reports and bulletin board messages.
- *Practice responsibilities*—Practice responsibilities comprise the role of

nursing clinician, administrator, researcher, educator, or informatics nurse specialist or of patient that describes the categories of activities performed by users.

- *Information functions*—The outputs of the first model element are nursing information functions and patient information functions and are defined as those activities requiring information handling associated with nurses' or patients' roles. Examples of nursing information functions are coordinating discharge information and communicating with patients during recovery. Examples of patient information functions are identifying benefits/barriers

of MCT and transmitting information about the status of recovery.

- *Constraints*—Identified constraints are nursing theory, patient role theory, professional standards and goals, and nursing and patient values.

Information processing element

This model element is defined by the processes of integrating information functions and practice responsibilities to describe nursing and patient information processing requirements.

- *Information processing requirements*—Nursing information processing requirements are the functional processes that nurse users believe a computer must perform as it manipulates data into information. Patient information processing requirements are the functional processes that patients believe a computer must perform as it accesses, manipulates, and transmits data and information. Manipulative tasks required of the computer are dependent upon users' practice responsibilities. Examples of nursing information processing requirements are showing the surgery date, procedure, and physician for a patient asking for information and providing a list of patients needing follow-up messages. Examples of patient information processing requirements are activating bulletin board connection automatically when a particular menu item is selected and providing reminders for key follow-up events.
- *Constraints*—Identified constraints for the second element are nursing and patient clinical experiences, nursing and

patient knowledge, readiness of nurses and patients, nursing and patient beliefs, and nursing and patient values.

Information systems element

The third model element is defined by analyzing nursing and patient information processing requirements, computer system characteristics, and existing computer systems to identify nursing and patient system outputs.

- *Computer system characteristics*—Computer system characteristics are the descriptive traits of a computer system that are expressed in computer language terms. These characteristics will reflect the ThinkPad and its capabilities.
- *Existing computer system(s)*—A computerized system that has already been installed in a facility or is planned for installation is an existing computer system. Economy and efficiency of information handling dictate that information systems be linked together to allow transfer of data across these systems.
- *System outputs*—Nursing and patient system outputs are the statements describing outputs (ie, computer screens or printouts) obtained from processing nursing and patient information with an information system.
- *Constraints*—Identified constraints are computer technology, developmental creativity, vendor interest, support for nurses and patients, and cost.

Information element

The information element is defined by the processes of combining nursing and pa-

tient system outputs and available data to determine data requirements.

- *Available data*—Available data are defined as computerized patient data that are available from other automated sources for storage, processing, or retrieval by an information system or user.
- *Data requirements*—Data requirements are categories of data or characteristics of data that must be included on the computer for nurses and patients to perform and document their information functions or to aggregate data for later decision making.
- *Constraints*—Identified constraints are professional standards, ethical beliefs, computer hardware, computer software, and traditions.

System goals element

This fifth and final element is defined by the processes of comparing data requirements, system outputs, and system goals to describe information system benefits for nurses and patients.

- *System goals*—Statements describing the desired end points of information handling for nurses and patients to which an information system is directed are the system goals.
- *System benefits*—System benefits are statements identifying the effects or outcomes of using an automated system to process nursing or patient information.
- *Constraints*—Identified constraints are user capabilities and understanding, health care agency goals, patient goals, nursing aims, and cost.

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A model for defining information requirements for MCT for older cardiac surgery patients to use after discharge from the hospital has been presented. The model has been adapted from earlier work and is believed to provide a more holistic definition of information requirements than traditional approaches to the process can supply.

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