CJNR

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EDITORIAL

Scholarly Communication and the Future of a Canadian Nursing Institution

I am very honoured to begin my term as *CJNR*'s Editor-in-Chief. In a sense I have grown up with the Journal, professionally speaking, from my days as a doctoral student at McGill University, when I assisted the Managing Editor in the *CJNR* office, through my postgraduate years when I wrote peer reviews, joined the editorial board, and eventually took up duties as Associate Editor while posted at other universities, and, finally, now that I have returned to McGill as a professor, in the position of Editor-in-Chief.

It is at once tremendously exciting and quite natural for me to take the reins from my mentor and friend, Dr. Laurie Gottlieb. After more than two decades as Editor-in-Chief, Dr. Gottlieb leaves *CJNR* on a solid footing. Under her guidance the Journal has developed into a leading outlet for Canadian scholarship in nursing and related health sciences, with a distinct international accent — a meeting place for early-, mid-, and late-career scholars to present work that might not easily fit elsewhere. It is our good fortune that Laurie will remain associated with *CJNR* as Editor Emeritus and that we will be able to draw on her expertise. Laurie deserves enormous credit for producing a journal whose upward shift in quality has mirrored the growth of academic nursing in Canada. Her decision many years ago to invite Canadian experts in subfields of nursing research to guest edit clusters of articles in their specialties was an astute one. She established and developed exceptional editorial processes with the collaboration and assistance of dedicated Associate Editors, Guest Editors, and Journal staff.

More than two decades ago, when I embarked on my career in nursing, reading articles and photocopying them was a demanding and sometimes tedious pursuit, requiring one to be present in the library during its regular hours. Carrying out a literature search meant consulting reference tomes or (for a brief period) early electronic versions of CINAHL and Index Medicus available on multiple CD-ROMs. Submitting articles for publication and then waiting for and responding to peer review and editorial decisions was a long and often expensive process before the days of e-mail, complicated by the vagaries of the

postal service. Waiting — to publish articles and to locate and read relevant articles — was the watchword. Now, in the Internet age, we spend less time waiting, as authors and as readers, but the number of journals has exploded, as has the number of nurses and other scholars eager to publish their work. The superficial mechanics of journal publishing and scholarship consumption have been streamlined, and it is easy to forget that journals are *primarily* a means for scholarly communication and that their role in building academic CVs or generating revenues to cover publication costs is secondary.

What has always amazed me about scholarly writing is the time invested by well-informed, hardworking people in drafting text to be read by unseen colleagues, as well as the amount of toil and quantity of resources expended in bringing their ideas to light. During my socialization as a researcher and then peer reviewer, editorial assistant, and, ultimately, editorial board member, I learned a great deal about the economics of journal publishing. From the perspective of the authors, of course, many career paths involve rewards for contributing to the scientific literature, while from the perspective of the journals there is always a need for a commodity that end-users are willing to pay for. However, the literature is first and foremost a means for reader and writer to communicate with each other. The quest for scholarly exchange is the beacon guiding high-quality, meaningful scholarship, whether this is analyzed at the level of the individual article, the scholar, or the journal.

I heartily agree with Laurie's analysis, in her last editorial, of all the challenges laid out in nursing, health care, and scholarly publishing. At *CJNR* we have been successful and relevant, but we cannot stop there. We must reinvent ourselves for our two core clienteles: readers and contributors. And we are comfortable being different from other journals in our content and in our organizational structure as we move forward.

Our vision for the future of the Journal is for *CJNR* to remain a key venue for the Canadian nursing research and scholarly community to disseminate its findings. We hope to make the international flavour stronger, however. We will always remain committed to publishing peer-reviewed, data-based articles in the solid methodological traditions in nursing and the health sciences. However, we are becoming increasingly cognizant of the fact that there are other forms of rigorous scholarship, equally worthy of publication, that do not necessarily fall into the conventional Introduction-Methods-Results-Discussion format of data-based quantitative articles. We know that there are ever-growing numbers of individuals at various levels in the profession carrying out and evaluating evidence-informed practice innovations; these authors deserve a venue to share their experiences, and, clearly, such experiences have a readership. Today's readers target specific articles and tend to make quick trips to

journal Web sites to pick them up — much as one might pick up MP3 files of songs from albums. They will not regularly visit sites or make serendipitous discoveries about other content that could be of interest to them unless we make it worth their while by offering appealing features. This is a time of profound change in health-care systems, research funding, and higher education in Canada and internationally. Useful, reliable information about trends affecting the careers of nurses involved in research, practice development, and education in the profession is not easy to come by, yet it is needed now more than ever before. Responding to the various needs and addressing all of the challenges will be part of our agenda in the coming years at *CJNR*.

I am most grateful that two dedicated Guest Editors were on board for this, my first issue as Editor-in-Chief. Drs. Elizabeth Borycki and Noreen Cavan Frisch of the University of Victoria have put together a wonderful issue on Nursing Informatics. Later this year you see will issues packed with interesting contributions on a variety of topics. When we shift to a Web presence exclusively in 2014, you will notice new features. Very soon you will be reading about our new editorial board structure and our new board, and as the year progresses you can expect to see a variety of calls for submissions in traditional as well as new scholarly formats.

To all those who have been involved in the Journal's successes since its founding 44 years ago, I offer a heartfelt thank you. The nursing community in Canada and internationally can count on us to continue providing a venue for the communication of important and innovative ideas. I look forward to working with all of you in growing *CJNR*'s role as a scholarly meeting place for our multifaceted and rapidly evolving profession.

Sean P. Clarke
Editor–in–Chief

Nursing Informatics in the 21st Century

Elizabeth M. Borycki, Noreen Cavan Frisch

In the call for papers for this issue of *CJNR* we asked for contributions from the nursing informatics research community on the topic of Nursing Informatics in the 21st Century. Today, health information systems are being implemented throughout the world in an effort to modernize health care. These health information systems, including nursing information systems, nursing decision-support systems, electronic health record systems, personal health record systems, and telehealth/telenursing systems, are improving the quality, efficiency, and safety of patient care. Over the past several years we have seen nurses lead the way in introducing these technologies in health-care settings across the care continuum. Nurses not only are proactive users of such electronic systems but are becoming increasingly involved in their design, development, implementation, evaluation, and maintenance. This work by nurses has become essential in ensuring that the new technologies support patient-centred care, nursing practice, nursing education, and the work of other health professionals such as physicians, occupational therapists, physiotherapists, and pharmacists.

This issue of the Journal features contributions by researchers in Canada, the United States, and the Caribbean. For example, Robert J. Lucero and Suzanne Bakken from the United States describe the Knowledge Discovery Through Informatics for Comparative Effectiveness Research (KDI-CER) framework and how it can be applied to the prevention of hospital acquired pressure ulcers (HAPU) (this article is published in the online edition only). Their work helps nurses and nurse administrators use data from electronic clinical databases to discover relationships between nursing interventions and clinical outcomes. The Canadian researchers Barbara L. Cross and Marjorie MacDonald have developed a theory of how nurses develop a relationship with the computer in their practice (published in the online edition). The authors interviewed 12 nurses to learn about how nurses integrate computers into their practice and the factors that influence the speed with which nurses take up the new technology. This grounded theory study provides

an empirically derived theory of how nurses adopt computer technology. We also go to the Caribbean region in this issue of *CJNR*. Pammla Petrucka and colleagues were able to facilitate nurses' practice in m-enabled health-care settings at five Caribbean sites. From an implementation perspective, the authors describe valuable information about the challenges, opportunities, and key lessons that have arisen from this work. More importantly, their article addresses the use of new tools (e.g., the personal digital assistant, or PDA, a software application that can be run on mobile devices) in supporting nurses' clinical practice and patient care. Internationally, in both the developed and the developing world, mobile devices and the health-care software applications that are associated with them are being recognized for their role in supporting nurses' work. More research is needed to identify evidence-based implementation approaches at the intersection of nursing and m-health.

For this focus issue of the Journal, we were open to empirical research (e.g., qualitative, quantitative, and mixed-method). The work of Diane M. Doran and colleagues illustrates the value of employing mixed-method (i.e., qualitative and quantitative) approaches to the study of clinical information systems deployed via a BlackBerry device for use by nurses practising in the community. The researchers used qualitative methods such as interviews and focus groups while at the same time employing a quantitative method (surveys). Qualitative findings arising from the interviews revealed that nurse, contextual, device, and assessment-tool characteristics influenced nurses' use of the clinical information system. In addition, quantitative findings revealed that user satisfaction had a positive association with social capital as well as structural and electronic resources. In another study, Selena M. Santi and colleagues employed a mixed-method design to learn more about the sharing of health information in home care. The researchers used a survey approach to obtain data on barriers to and facilitators of the use of electronic health information systems. The results of the survey were presented at a workshop and a "world café." Participants at these events were asked to develop strategies and interventions for facilitating the exchange of health information. Such mixed-method work is crucial to the development of an in-depth understanding of the uptake of a technology and the factors that influence that uptake.

In putting together this issue of the Journal, we have observed an increasing focus on nursing informatics in educational settings. Manal Kleib and colleagues outline the need for a new approach to integrating informatics into undergraduate nursing education (published in the online edition) — an approach that is more focused and consistent in terms of duration and educational strategies. As these authors point out, we need to continue specifying the core informatics content required in

baccalaureate nursing education. As well, Marjorie McIntyre and colleagues report on their critical analysis of online nursing education. This is one of the few studies in the field of health informatics to employ a hermeneutic methodological approach — a significant extension of research methods in the domain. These authors critically examine some of the challenges and issues that are part of online learning and highlight a number of the key questions that nurses need to address when working with online educational tools. Lastly, June Kaminski reviews *Informatics and Nursing: Opportunities and Challenges* by Jeanne Sewell and Linda Thede. This book defines, documents, and discusses nursing and informatics within the context of information management, computer competency, and information literacy.

Nursing informatics research, as exemplified by the articles published in this issue of the Journal, is needed in order to move health care into the future. We have highlighted some of the advances being made in nursing informatics in Canada and internationally. As illustrated by the range of topics explored and the range of approaches taken by the work reported herein, we need to adopt an open perspective on both the type of problems that can be successfully addressed and the type of approaches that can be taken to deepen our understanding and resolve complex nursing problems through the use of technology.

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Discourse

Informatics and Interprofessionality

Noreen Cavan Frisch, Elizabeth M. Borycki

Informatics and Interprofessionality:
Is Nursing Caught in the Middle?

In Canada, as in many parts of the world, electronic health records (EHRs) are being developed and implemented as a means of managing data in support of clients' health. We have developed a field of health informatics — the application of information technologies to facilitate the creation and use of health-related data and knowledge. According to Canada's Health Informatics Association, the goal of health informatics is simply to use information technology to help Canadians achieve better health (Canada's Health Informatics Association [COACH], 2013). Nursing informatics is considered a subfield of health informatics drawing on nursing science and knowledge (COACH, 2009; Shortliffe & Cimino, 2006). It provides nurses with tools for data capture, storage, and retrieval for the purpose of delivering and evaluating nursing care. The most recent definition provided by the International Medical Informatics Association (2009) reflects this emphasis: "Nursing Informatics science and practice integrates nursing, its information and knowledge and their management with information and communication technologies to promote the health of people, families and communities world wide." As we move towards increasingly technologically enabled work environments and the digital documentation of our work, we nurses are in a position to use our knowledge and our analytic abilities to identify nursing's phenomena of concern, document when nursing is needed, and track the probable outcomes of nursing care. With the appropriate technologies in place, nursing will be better able than ever before to articulate its unique disciplinary contributions to client care.

In some ways, nursing could not be in a better position to use technologies and information to document what we already know — that professional nursing contributes to the health, healing, and recovery of the clients we serve. Further, technologies and documentation can be used to increase our knowledge about when and why nursing fulfils this role.

However, concurrent with the launching of our EHRs and our digital recording of health-care practices, we are moving away from a disciplinary perspective and towards a practice that is interprofessional in nature. Interprofessional practice demands that we collaborate on the delivery of patient-centred care across disciplines (D'Amour & Oandasan, 2005). Both informatics and interprofessionality have positive contributions to make to client safety and quality care. Nonetheless, they can cause tension for nurses, pulling us in two directions. Can we as nurses develop our own discipline and at the same time break down disciplinary boundaries? The purpose of this discussion is to articulate what the discipline of nursing needs to do to fully participate in interprofessional practice, what nursing needs for its own development, and to suggest ways in which the two perspectives can be integrated into our EHRs without compromising either nursing or our ability to collaborate with other professions.

Interprofessionality and Nursing

In 2005 our attention was drawn to the fact that care was fragmented, usually across disciplinary lines, leaving clients without a coherent approach to care management (D'Amour & Oandasan, 2005). Though the word "interprofessional" had been used previously, D'Amour and Oandasan presented it as a new concept — one that would bring health professionals beyond the interdisciplinary perspective, which merely acknowledges that several disciplines contribute to a client's care. D'Amour and Oandasan define "interprofessionality" as "the development of a cohesive practice between professionals from different disciplines" (p. 9).

Interprofessionality was thought to require a paradigm shift, as health professionals would need to engage in thoughtful interaction and ongoing dialogue with one another and with their clients. Together, the team of health professionals and clients would be able to design care practices such that client needs could be met in a holistic manner.

Almost immediately there were discussions about the need for interprofessional education in order to achieve interprofessional practice. D'Amour and Oandasan (2005) presented their Interprofessional Education for Collaborative Patient-Centred Practice model describing the factors by which professionals become collaborative practitioners. Their model separated learner outcomes from practice outcomes, acknowledged the interdependence of education and practice, and called for major changes in professional training to bring different perspectives together.

Since 2005, specific teaching approaches have also been suggested. For example, Deutschlander, Suter, and Lait (2012) report on the benefits of having students from different disciplines share clinical practice sites while participating in mentoring, workshops, and discussions (in addition to their regular course work). This model illustrates the benefits of having students in the health field learn together, not just about patient needs but also about how the perspective of each profession enriches the knowledge of the entire health-care team and the quality of the team's decisions. Other authors have developed competency frameworks for curricula and offer guidance on the knowledge, skills, and attitudes that professionals need in order to engage in collaborative practice (Wood, Flavell, Vanstolk, Bainbridge, & Nasmith, 2009). In 2007 the Accreditation of Interprofessional Health Education Initiative was founded, funded by Health Canada (http://www.afmc.ca/projects-aiphe-e.php), and Canadian schools in the health field began to incorporate interprofessional preparation into their approval and recognition standards. The competency frameworks provide a structure for the health professions to form true collaborations. Nonetheless, the interprofessional literature has not fully addressed the role of each discipline or profession in relation to its own scope of practice, overlapping scopes of practice, or the need for each discipline to develop and research its own knowledge and tools. Practitioners and institutions are left to navigate the newly created boundaries on their own.

The movement towards interprofessional education and practice is now well established. A review of the literature indicates that our body of knowledge on interprofessionalism is still being developed. But while further research on the outcome and impact of interprofessional practice is needed, interprofessional practice has been shown to have a number of benefits, including enhanced communication across disciplines — which may in turn lead to improved dialogue and increased use of evidence in practice (Zwarenstein & Reeves, 2006). On many occasions the interprofessional movement has demanded that professionals abandon their practice silos. For nursing this means that we must work with colleagues in other health professions on the assessment, planning, and delivery of care. It does not mean that nurses need to abandon their knowledge and practice base in order to participate, but nursing must find a way to contribute its knowledge and practice base to the interprofessional team. Ultimately, this means that nurses must be able to function in two domains: the part of nursing practice that ensures that decisions made by the interprofessional team are acted upon in a manner that is truly supportive of patients' needs and contexts; and the part that requires an independent nursing assessment, judgement, and nursing action, and that uses practice data to evaluate and track nursing outcomes and effectiveness.

Noreen Cavan Frisch, Elizabeth M. Borycki

Nursing's Disciplinary Needs and Nursing Terminologies

For the development of nursing as an applied and practice discipline, nurses need documentation that includes data that will not only record nursing judgements and actions, but also permit retrieval of nursing data for quality purposes and the development of practice-based evidence for nurses and interprofessional teams. To accomplish this, nursing must draw on its history, its use of theory, its knowledge, its research, and its substantial work in developing client-centred approaches to care.

Nursing, through its many successive versions of the nursing care plan, has provided guidelines for the identification, treatment (or intervention), and probable outcomes of care that partners with patients and focuses on human responses to health conditions and treatments. In a span of 40 years, nursing has developed no fewer than 15 standardized terminologies for describing, guiding, and documenting discipline-specific practices and outcomes. These terminologies allow for the recording (in shorthand) of the judgements, priorities, and activities of professional nursing. Some relate to specialty practice (the Perioperative Nursing Data Set or the Omaha System — originally developed for home and community care), while others encompass the scope of nursing practice (the International Classification of Nursing Practice [ICNP] or the NANDA-NIC-NOC documentation of nursing diagnoses, interventions, and outcomes). The terminologies provide a name for a nursing concern (usually called the "nursing diagnosis") that is computer-codable as well as a means to record nursing actions and to document and evaluate nurse-sensitive outcomes. In most implementations of these terminologies, nurses also provide narrative descriptions of the contexts of the care decisions, their interactions with patients, and the outcomes of the nursing care. These terminologies are the most effective way to document nursing in modern, digital records and, when they are part of the EHR, provide volumes of practice data on which to build the discipline (Jones, Lunney, Keenan, & Moorhead, 2010; Thoroddsen, Ehnfors, & Ehrenberg, 2010).

The Canadian Nurses Association endorsed the ICNP as an appropriate standard for use in Canada in 2008 (Canadian Nurses Association & Canada Health Infoway, 2008), yet there is still no fully operating system implemented in an EHR anywhere in the country. The Health Outcomes for Better Information and Care initiative is an important first step in documenting nursing assessments and outcomes, but its implementation has been limited. Many nurses see e-health implementations as purporting to serve interprofessionalism yet built to include the International Classification of Diseases (ICD) medical terms and lists of tasks and/or activities needed to accomplish the work of the healthcare team. The result, especially for nursing, is that important elements of

practice are not being recorded and the data required to build knowledge and enhance quality of care are unavailable.

Integrating Nursing and Interprofessionality Into the EHR

The EHR may provide a way to address tensions between nursing and interprofessional practice. Modern health care demands that we employ disciplinary–specific knowledge bases while at the same time supporting interprofessionalism. The EHR is a tool that can serve both, as long as it is designed, developed, and implemented to support the individual work of health professionals in addition to the collaborative work of inter-professional teams. Technology designers, as well as members of nursing and allied health disciplines, need to appreciate and articulate the value of encouraging health professionals to draw on their disciplinary knowl-edge while also collaborating with members of other health professions to resolve complex client problems. This involves, in some cases, the use of disciplinary terminology.

In several countries EHRs have been developed to support termi-nologies from many disciplines (Häyrinen, Saranto, & Nykänen, 2008). These EHRs "can carry out the tasks for which they were designed using data and information taken from" another EHR "as seamlessly as using its own data and information" (Ceusters, n.d., p. 1). Such EHRs are considered to have a high degree of semantic inter-operability (Ceusters, n.d.; Häyrinen et al., 2008). As a result they can support different disciplinary and interprofessional information-seeking, decision-making, and workflows. Semantic interoperability allows health professionals to view data from other disciplines (e.g., a physician can view nursing data using a medical lens; a nurse can view social work data using a nursing/home care lens). To find out if a patient is respond-ing to a new medication, a physician can view information on the medication and on the patient's response — for example, how easy it is for the patient to take his medication (e.g., the capsule is difficult to swallow) and the patient's opinion on the medication regime (e.g., four times per day is difficult to work into his daily pattern). A nurse viewing data gathered by the social work service could learn more about a patient's home supports. This might include the presence of a caregiver who is available each morning, but not at night, to support medication adherence. A physician viewing social work data may learn that the pre-scribed medication is far too expensive for the patient to purchase without drawing financial resources away from the family. An inter-professional plan of care would certainly be feasible in settings where each professional obtains information from others and the plan of care is informed by all perspectives. For nurses in Canada, use of such an

EHR will require changes to our record system and will involve the procurement, selection, customization, and implementation of systems to support team or interprofessional work. Our technology must advance beyond providing a single view of the patient record that does not take into account all of the disciplines involved in the patient's care.

We call on nurses, particularly those interested in informatics, to take the lead and advocate for EHRs that support nursing and interprofessional practice. We submit that there is nothing in interprofessional practice prohibiting any discipline from using its disciplinary tools to contribute to client care. In fact, the opposite is true. Interprofessionalism at its best encourages each profession to consider the perspectives, judgements, and activities of other professions as well as its own. Knowledge gained from robust EHRs can only improve the quality of care and serve the advancement of health. The representation of nursing in interprofessional EHRs will necessarily include standard nursing terminology, a nursing care plan (or an interprofessional care plan that tracks care provided by each profession), and the ability to link client outcomes with nursing judgements and actions. And it will necessarily require input from other professionals and incorporation of their disciplinary perspectives.

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Résumé

Combler le fossé :
l'échange d'information sur les soins à domicile

Selena M. Santi, Stephanie Hinton,
Katherine Berg, Paul Stolee

Comme dans bon nombre de secteurs de la santé, des sommes importantes ont été investies dans les soins à domicile dans le but d'implanter des systèmes électroniques d'information sur la santé (SEIS) ainsi que les instruments d'évaluation normalisés qui s'y rattachent. Même si l'on reconnaît que ces systèmes offrent la possibilité d'améliorer la qualité des soins, leur adoption dans le secteur des soins à domicile au Canada est loin d'être achevée. Notre enquête visait à recueillir des données sur les facteurs qui font obstacle ou facilitent l'implantation des SEIS (n = 22). Les résultats ont été analysés dans le cadre d'un atelier (n = 30); de plus, une séance « World Café » a été menée pour envisager les stratégies et les interventions susceptibles d'améliorer l'échange de renseignements, notamment en ce qui touche les soins de réadaptation à domicile.

Mots clés : soins à domicile, systèmes électroniques d'information sur la santé, échange d'information, qualité des soins

Bridging the Information Divide: Health Information Sharing in Home Care

**Selena M. Santi, Stephanie Hinton,
Katherine Berg, Paul Stolee**

As in many health sectors, in home care there have been significant investments made in electronic health information systems (EHIS) and accompanying standardized assessment instruments. While the potential of these systems to enhance the quality of care has been recognized, it has yet to be fully realized in Canadian home care settings. Data on EHIS barriers and facilitators were collected using a survey ($n = 22$). The results were discussed at a workshop ($n = 30$) and a "world café" session was held to consider strategies and interventions for improving health information exchange, with a focus on home care rehabilitation.

Keywords: aging, care delivery, gerontology, health services, home care, informatics

Introduction

In Canada approximately one in 10 persons aged 65 years or older receives formal home care services (Carrière, 2006). Home care "encompasses health promotion and teaching, curative intervention, end-of-life care, rehabilitation, support and maintenance, social adaptation and integration, and support for the informal (family) caregiver" (Ontario Home Care Association [OHCA], 2010a). In Canada home care has been called "the next essential service" (Romanow, 2002) and is one of the fastest-growing sectors in health care (Canadian Home Care Association, 2007). The escalating dependence on home care to address the needs of older adults renders health information use and sharing critical to ensuring an effective system of care because of the complex needs of clients, multiple providers working across settings, consultations needed for specialized care, and emergency department visits for acute care (Vaidya et al., 2012; Vimarlund, Olve, Scandurra, & Koch, 2008). Standardized assessments facilitate the sharing of health information across settings, providers, and organizations by establishing a common language and metrics to describe and communicate client needs (Stolee, Steeves, Glenny, & Filsinger, 2010) and by populating electronic health information systems (EHIS).

Selena M. Santi, Stephanie Hinton, Katherine Berg, Paul Stolee

In Canada there are several examples of standardized assessments being used as routine clinical practice in various settings. These include OASIS (Outcome and Assessment Information Set) developed by the Centers for Medicare and Medicaid Services (2012), with items added by the Vancouver Coastal Health Authority in British Columbia. An additional assessment used is the Outil d'évaluation Multiclientèle (Multiclientele Assessment Tool), which includes the SMAF (Functional Autonomy Measurement System) mandated for use by the Quebec health and social services system (Santé et Services Sociaux, 2002). Ontario, in particular, has made significant progress towards the development of a fully integrated health information system by leveraging the standardization and harmonization of the interRAI suite of tools.

The importance of engaging health professionals and understanding their needs has been widely recognized as essential to introducing and sustaining change (Gauthier, Ellis, Bol, & Stolee, 2005; Rycroft-Malone et al., 2002), which includes the implementation of EHIS and other information technologies (Doebbeling, Chou, & Tierney, 2006). As stated by the Change Foundation (2011b), clinicians' "involvement in the design and implementation of e-health components will be critical to the strategy's success" (p. 26).

Background

Home care managers and providers have identified a number of challenges related to the effective use and sharing of health information in practice (Stolee, Steeves, Manderson, et al., 2010). These challenges include costs associated with the implementation and maintenance of new technology, training costs and initial loss of productivity related to learning a new system, staff resistance, and user resistance to technology and new systems. Vaidya and colleagues (2012) highlight other challenges related to point-of-care access and the need for health information to facilitate clinical decision-making.

Clients have also recognized inadequate information sharing. In a population survey conducted in Ontario, 41% of respondents were not confident that their health-care provider had all the necessary information related to their health (Change Foundation, 2008), since information often is not conveyed on time or at all (Change Foundation, 2011b). In a study of health information exchange and personal health records from a consumer perspective, Patel and colleagues (2011) found that 61% of clients supported the electronic transfer of their health information across providers and settings and perceived the benefits of sharing information related to the completeness and accuracy of their medical records, receiv-

ing care that met their needs, spending time with the doctor answering questions, improved outcomes such as better quality of care, and safety.

There have been significant EHIS investments in home care. The Resident Assessment Instrument-Home Care (RAI-HC) (Morris et al., 1997), developed by an international consortium of investigators, is mandated for use in several Canadian provinces — Alberta, British Columbia, Newfoundland and Labrador, Nova Scotia, Saskatchewan, and Yukon — and for partial use within individual organizations/health regions in Manitoba (Heckman, Gray, & Hirdes, in press). The RAI-HC contains over 300 items measuring health, functional status, and other client characteristics and is used to inform and guide comprehensive care and service planning in community settings (Hirdes et al., 1999; Morris et al., 1997). Components of the RAI-HC system include embedded outcome measures and quality indicators as well as algorithms that trigger clinical assessment protocols (CAPs) for specific assessment areas that require further investigation. The standardized format of the assessment tool and related applications supports effective information sharing between care settings and care providers. While these data are used for mandatory reporting, they are often underutilized in clinical practice (Egan et al., 2009; Stolee, Steeves, Manderson, et al., 2010).

Challenges with information sharing may be partly a function of how home care is organized and delivered. The role of Community Care Access Centres (CCACs) is to provide single-entry access to home care by determining a client's eligibility for services and purchasing/coordinating these services (Canadian Healthcare Association, 2009), to be provided through a separate agency. The agencies are contracted by CCAC to implement care plans and conduct their own discipline-specific assessments (Ontario Association of Community Care Access Centres, 2010). In this model, the CCAC case managers oversee the administration of services, while contracted service providers are responsible for direct care.

The RAI-HC is used by CCACs in Ontario to assess home care clients who are expected to require services for 60 days or more (Canadian Institute for Health Information [CIHI], 2011). Although this assessment information is collected and used by CCACs to determine eligibility and coordinate services, the information or summary profiles are not often transferred to service providers (e.g., nurses, physical therapists, occupational therapists) or their respective agencies (Stolee, Steeves, Manderson, et al., 2010). As noted by De Vliegher, Paquay, Vernieuwe, and Van Gansbeke (2010), there is a "direct relationship between quality of care and the quality of information available to health care professionals and the process of clinical information and communication" (p. 508). While the capacity of these systems to enhance the quality of care has

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been recognized (Russell, Rosenfeld, Ames, & Rosati, 2010), their potential has yet to be fully realized in Canadian home care settings.

The present investigation was part of an iterative study to identify factors and possible interventions that support or hinder health information sharing in home care, with a focus on home care rehabilitation. Earlier phases included focus group interviews with home care case managers (Egan et al., 2009), a systematic literature review (Stolee, Steeves, Glenny, et al., 2010), and three 1-day facilitated workshops — Knowledge Exchange Panels (KEPs) — with a total of 40 participants (Stolee, Steeves, Manderson, et al., 2010).

The goal of the present study was to develop an inclusive list of barriers and facilitators related to the effective use and sharing of health information in home care, through an iterative approach that included a stakeholder survey and a knowledge exchange workshop.

Methods

This study was guided in part by the iterative process outlined by Flottorp and Oxman (2003) for identifying barriers and developing "tailored interventions." Results of previous work (Egan et al., 2009; Stolee, Steeves, Glenny, et al., 2010; Stolee, Steeves, Manderson, et al., 2010) were used to generate an extensive list of potential barriers to and facilitators of health information sharing in home care; these then formed the basis of a survey encompassing nearly 100 items. The PARiHS (Promoting Action on Research Implementation in Health Services) framework was applied in this study to organize the findings and assess the potential for use of health information in practice.

Survey

A survey was distributed to the 40 original KEP participants, located in three regions of Ontario (Stolee, Steeves, Manderson, et al., 2010). Respondents were asked to rate the importance of each item on a 10-point scale (with higher values indicating greater importance) and to identify additional items that they felt were missing from the lists. The survey was distributed as an online form and was available to participants over a 3-month period. The purpose was to uncover the relative importance of the items, to ensure that the list of factors adequately reflected the experience of the participants, and to reduce the possibility of social desirability bias (i.e., difficulty with openly sharing information based on occupation and/or role) (Schwartz, Verkasalo, Antonovsky, & Sagiv, 1997). Survey data were entered and analyzed using IBM SPSS version 19 (2010).

Mean ratings were used to rank items in various categories in terms of importance; standard deviation was used to indicate the variability in responses. A comparison of means was used to analyze responses from two groups of participants (CCAC representatives and respondents from contracted provider agencies). Additional items generated by respondents through the open-ended fields were examined and it was concluded that all participant-generated items had been included under other sections of the survey. The results were then presented and discussed at a workshop, as a base of information for exploring strategies for improving information sharing in home care.

Workshop

Following completion of the online survey, a 1-day workshop was held in Toronto, Ontario. Of the 30 people who attended, nine were original survey respondents and the remaining 21 were other stakeholders: researchers and graduate students ($n = 8$), CCAC administrators ($n = 5$), policy-makers ($n = 4$), quality improvement leads ($n = 3$), and a facilitator ($n = 1$). We included the additional stakeholder groups (beyond the original KEP participants) to assess the transferability of the findings by highlighting their applicability to other roles in home care (Golafshani, 2003).

The first half of the workshop focused on disseminating the findings from the survey and engaging attendees in a collaborative process to ensure that the interpretation of the results properly reflected the experiences of all participants (Mays & Pope, 2000) and that no notable items were omitted. The second half comprised a series of presentations highlighting current interventions and policies in home care followed by a "world café" session. The world café allowed small groups of participants (3 to 5 individuals) to move through a series of stations to collaboratively discuss and answer predetermined questions and thus to foster the cross-pollination of ideas (Schieffer, Isaacs, & Gyllenpalm, 2004). The benefit of using the world café technique is that groups build on the responses of others, enabling everyone to take part in the discussion.

Participants were asked to reflect on and discuss strategies for enhancing use of the RAI-HC. Specifically, they were asked to give direction on how to develop and provide educational opportunities to use the RAI-HC and to identify information applicable to their work, as well as to indicate how improved use of health information supports the goal of integrated client services.

The world café data were analyzed using a hybrid approach to thematic analysis combining the processes of inductive and deductive reasoning (Fereday & Muir-Cochrane, 2006; Hsieh & Shannon, 2005). The units of analysis were the recorded notes derived from the predetermined question topics. The data were initially analyzed using

the deductive framework outlined by Elo and Kyngäs (2008). Two researchers individually condensed meaning units and coded and categorized the responses into subthemes according to predefined categories (guided by the discussion questions). The researchers then met with a third party (who was otherwise unattached to the research) to review the data, discuss the final coding structure (Larsson, Nordholm, & Öhrn, 2009), and help ensure the credibility of the findings (Graneheim & Lundman, 2004; Hsieh & Shannon, 2005). The data were then aggregated across questions and analyzed inductively (Elo & Kyngäs, 2008; Graneheim & Lundman, 2004) (Figure 1). The higher-level themes, subthemes, and categories were incorporated into the PARiHS framework under the categories of context, facilitation, and evidence (Figure 2). Specifically, the context domain includes culture, values, decision-making processes and feedback mechanisms, and physical resources. Evidence consists of research and reflects clinical experiences, client references, and information from the local context. Lastly, facilitation is aimed at easing/enabling actions or processes, including the achievement of specific tasks, skills development, process changes, and attitudinal changes. While the PARiHS framework traditionally involves three domains, Conklin and Stolee (2008) include a fourth domain, "results," to ensure consideration of the desired clinical or program outcomes of

Figure 1 *Data Analysis*
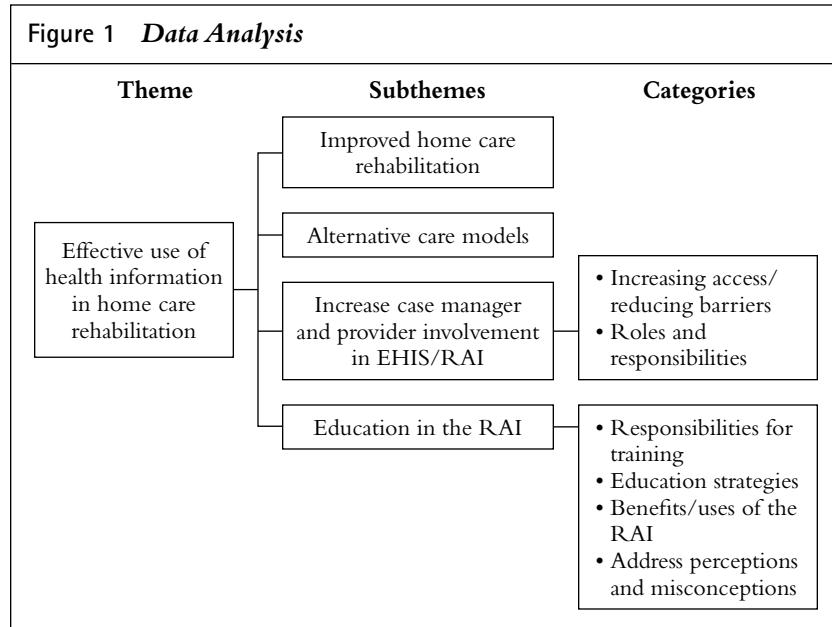
Figure 2   *PARiHS Framework*

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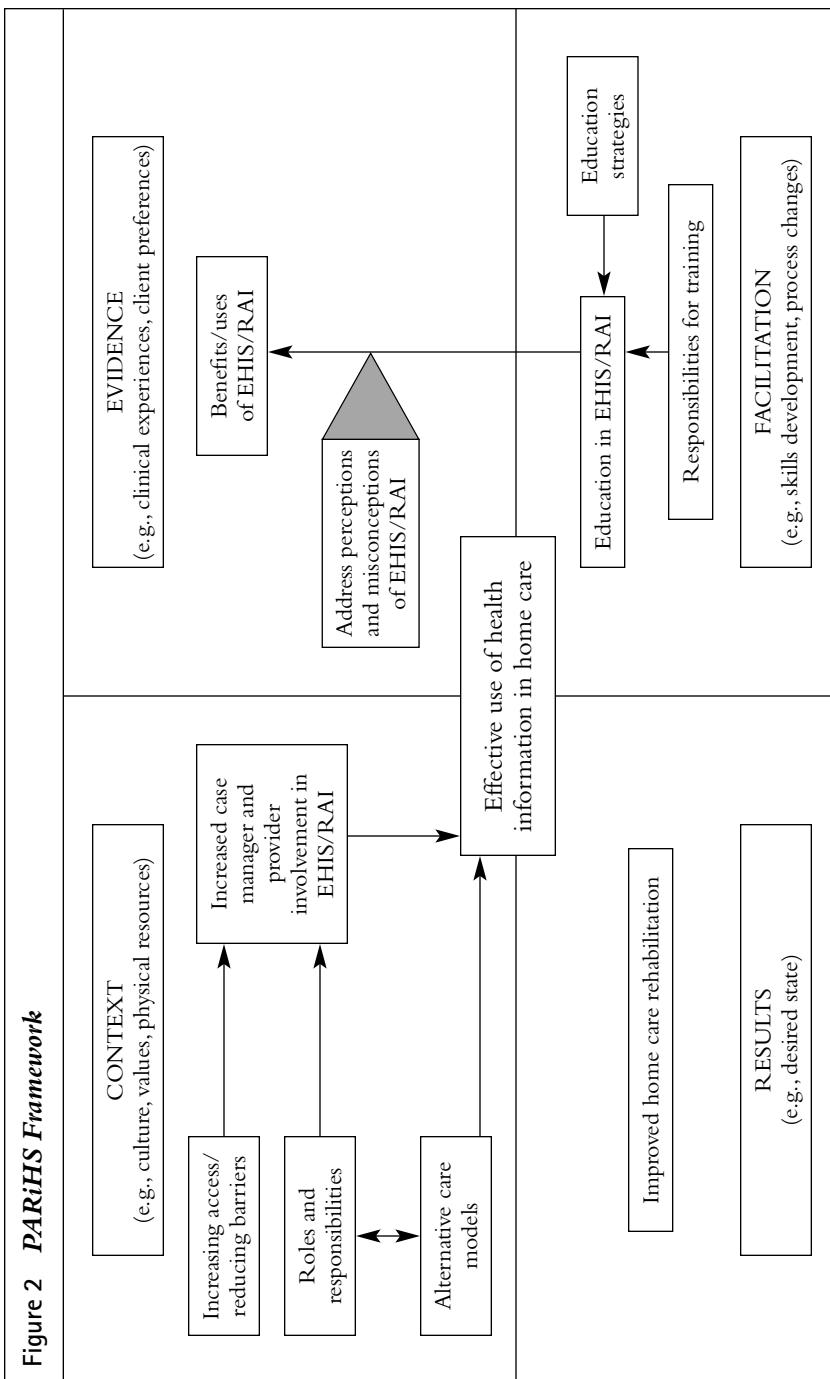
the exchange of knowledge or information. In this case the desired outcome was improved home care rehabilitation through increased information sharing among home care administrators and providers. The complexities and relationships between the context, evidence, and facilitation domains needed to be understood and considered, as they related to effective use of health information before strategies to improve home care rehabilitation (results) could be implemented.

Ethics clearance was secured from the research ethics offices at the universities of Waterloo and Toronto. Clearance to recruit at participating agencies was obtained and key administrative staff assisted with recruitment. Submission of the completed survey signified consent to participate (as outlined in the information letter). Workshop participants provided written informed consent prior to the start of the session.

Results

Survey

We received 22 responses to the survey (55% response rate). The majority of respondents were female (*n* = 19). Combined, 11 participants were administrators from service provider agencies (*n* = 6) and CCAC case managers (*n* = 5) (most case managers are registered nurses), five were physical therapists, four were occupational therapists, and two were nurses.

The responses (ratings on a 10-point scale) were combined across all participants to find the mean rating and standard deviation for each item. Factors categorized as facilitators of health information sharing were viewed as important by all participants (see Table 1). Rank ordering of responses by participant group (i.e., respondents from CCACs vs. those from service provider agencies) differed for items related to the application and utilization of EHIS in home care (e.g., RAI-HC CAPs to inform care were viewed as important by both groups, but outcome-based assessments and quality indicators were ranked as essential only by CCAC respondents). In terms of preferred modes of communication, CCAC respondents preferred phone and fax while service providers preferred phone and e-mail. Also, important details to have when using health information (e.g., Personal Health Profile [PHP]) in home care varied by respondent group. While both groups rated all items as important in a PHP, the rank order differed (e.g., CCAC respondents rated information about the clients' emergency room reports and medical orders as more important, whereas service provider respondents rated information about safety needs and functional status as more important).

Table 1 *Mean Ratings for Survey Items*

Category	Items	Mean Rating	SD
Facilitators of Sharing Health Information			
Processes for improving information sharing	Consistency in client information collected	9.00	.98
	Uniform procedures used to share information	8.55	1.18
Sharing client information with others	Peer consults	8.29	1.35
	In-home conferences	8.23	1.88
Factors for creating a supportive work environment	Opportunities to engage in continuing education	8.50	1.26
	Management support for learning new tools/ strategies for improved client care	8.38	1.43
Using EHIS to communicate with others	Easily accessible	8.91	1.41
	Clearly formatted	8.86	1.46
Supports for users when adopting EHIS	Technical support	9.14	1.21
	Training using the system (e.g., IAR)	9.00	1.20
Supportive factors for adoption of EHIS	User participation at the time of development	8.86	1.32
	Managerial support	8.68	1.04
Issues when using EHIS to collect client information	Security/client confidentiality is maintained	9.59	.96
	Maintaining a client-centred focus during visits	9.59	.59

Continued on next page

Table 1 (cont'd)

Category	Items	Mean Rating	SD
Facilitators of Sharing Health Information			
Applications of EHIS in home care	To use data for care planning	8.95	1.00
	To show outcomes on home care–based rehabilitation	8.73	1.24
Barriers to Sharing Health Information			
Ability to share information effectively with other providers	Lack of detail in referrals	8.05	2.26
	New referrals missing basic information/ referral reason	7.95	2.84
Ability to use information effectively in home care	Lack of common platform for information sharing	7.50	2.24
	Quantity of information gathered by tools differs	6.36	2.42
Organizational factors for communicating	Limited time to communicate with providers	7.55	2.13
	Large caseloads	7.45	2.28

Follow–up Knowledge Exchange Workshop

The results of the survey were presented to workshop attendees, who were then asked to respond and comment on omitted and/or unexpected results. Attendees were able to provide as many responses as they wished. Their issues/concerns about the findings are explored below (only differences are noted).

Comments focused on the use of shared information systems that allow for consistent client information to be utilized by all providers involved in the client's circle of care. Incorporating shared information systems into practice to promote communication and exchange of valuable patient information among all providers was a frequent topic. For instance, one respondent stated that there is a "need [for] more sharing of information, particularly the specialized assessments completed by the provider." Another respondent expanded on this idea, noting the usefulness of "having CCAC and service providers input information directly in the same client record. This would improve access to consistent information." The lack of joint information systems and transfer of RAI data between CCAC and service provider agencies "result[s] in duplication of services; impedes common goals and continuity of care [so that] outcomes can be measured to ensure effective and efficient utilization of services and resources to improve accountability."

Attendees commented on their preference for e-mail over telephone, indicating that e-mail was not being used by all home care professionals because of privacy concerns. One respondent said, "There's no secure network between the CCAC and service provider agencies." Further, the home care sector is "looking [at] how to use e-mail more when a great deal of sectors are discouraging its use" because of both security and policy issues.

Cost was not a central component of the survey, as participants had little say in the purchase of programs and tools that are mandated for use. However, one participant noted that cost should be highlighted as a barrier, stating, "Service providers end up paying for any of these progressive measures themselves," and that this should therefore be included when assessing the feasibility, uptake, and use of EHIS among home care professionals.

Another topic of discussion was the RAI-HC. The importance of provider agencies receiving outcome measures from the RAI-HC was discussed. One attendee stated, "[I'm] surprised by the lack of reference to outcome measurements that could be leveraged in the RAI. I think this omission reflects a lack of understanding of RAI."

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World Café Session

The world café responses were coded deductively (guided by the discussion questions) and aggregated inductively to create six higher-level categories and four subthemes organized around one central theme (Figure 1). The central theme, *effective use of health information in home care rehabilitation,* was used to contextualize and categorize the results into subthemes and categories. It included having access to standardized, complete, up-to-date information in order to construct a more informed client profile.

The first subtheme, *improved home care rehabilitation,* included increased awareness of the underutilization of rehabilitation services in home care and appropriate use of rehabilitation services to enhance outcomes (e.g., preventing admission to long-term care). The second, *alternative care models,* included suggestions for bundling rehabilitation services by using a lead provider agency as a primary contact and allowing for the adjusting and tailoring of care plans throughout the rehabilitation process (e.g., allowing for more communication between individual providers). The third subtheme, *increased CCAC case manager and provider involvement in EHIS/RAI,* covered two categories: (1) increasing access/reducing barriers (e.g., increasing the timely exchange of information across settings and between providers); and (2) roles and responsibilities (e.g., allowing care providers to conduct assessments typically done by case managers). The final subtheme, *education in using the RAI,* comprised four categories: (1) responsibility for training (i.e., who should provide training?); (2) education strategies (e.g., establishing a standardized mode of delivery across sectors); (3) education in the benefits/use of RAI (e.g., the ability to communicate in a common language across sectors); and (4) addressing perceptions and misconceptions (e.g., the role of the RAI-HC and its potential applications in improving care delivery and outcomes of care are not well understood).

Discussion

Applying the results to the PARiHS framework allowed for a comprehensive understanding of factors to consider when attempting to improve home care rehabilitation (Figure 2). The theme and subthemes were mapped using the PARiHS framework depicting the interrelationships within each domain (context, evidence, facilitation, and results).

The workshop revealed a lack of understanding regarding the applications of standardized assessment information in home care (e.g., client populations, underserved client groups, the quality of care provided), and thus a lack of understanding of the current *context.* While *evidence* of the benefits of using and applying information collected from the RAI-HC

was discussed, *facilitation* is needed in order to implement the tools. One focus of discussion was the lack of knowledge about the use and applications of the RAI-HC. While some participants understood the benefits of using the RAI-HC for assessment purposes, many were unaware of how the information collected could be utilized by other health professionals for benchmarking and improving quality (OHCA, 2010b). With the introduction of tools such as the Integrated Assessment Record (IAR) (Community Care Information Management [CCIM], 2012) and client health summaries such as PHPs, health professionals will have to be educated in information uses and applications, as integration of services could result in client records becoming available to all health professionals involved in the client's circle of care before and after the provision of home care. Who should be responsible for the training associated with the RAI-HC? This has yet to be determined. Suggestions ranged from CCAC case managers to governing bodies and centralized organizations (e.g., CIHI). Regardless, participants conveyed the idea that training must be standardized across all sectors in order to ensure a more sustainable system.

Information sharing and the use of standardized assessment information can lead to more effective integration of care and improved outcomes (Change Foundation, 2011a, 2011b; Hirdes, 2006; OHCA, 2010). However, barriers to information sharing (Stolee, Steeves, Manderson, et al., 2010) need to be considered and addressed in the tailoring of programs and interventions within the home care sector. When respondents were asked about the type of information they would like to have about a client, the priorities differed for case managers/administrators and home care providers. This suggests a need for tailored interventions (Flottorp & Oxman, 2003) along with a need for strategies that support the sustainability of changes in practice (Rycroft-Malone et al., 2002).

This study focused on the use of the RAI-HC as an example of an EHIS that provides context about the issues of disconnect between CCAC/provider information needs. Future studies might consider comparing different components and types of EHIS, such as the effectiveness of the IAR in meeting the information needs of health professionals across the care continuum and determining whether access to more information improves client outcomes and quality of care. Also, training considerations need to be informed by the user's data-input methods and system-navigation needs. Education could focus on the importance of the aggregate health data collected through EHIS and on using data to inform practice and advocate effectively for clients.

A limitation of the study was the time lapse between the initial KEP sessions and the distribution of the survey. This likely served to reduce the response rate and heighten the importance of the final workshop. We

also distributed the survey to people who attended a home care associa-tion event but did not attend the original KEP sessions, and found similar results. In order to maximize the generalizability of the findings, we con-ducted the research at centres located in large cities, mid-size cities, and rural areas. Since the study was an initial step in understanding the bar-riers to and facilitators of information sharing, clients and their informal caregivers were not included. Future studies could examine the impor-tance of information sharing from the perspective of clients and their families, to ensure that the information being collected meets the needs of all parties (Sidani & Braden, 2011).

Recommendations and Conclusion

Four core recommendations emerged from the study. These are discussed in light of models of care, e-health developments, policies, and organiza-tional structures. Recommendations include the need to: (1) engage stakeholders in a consultative process when creating, designing, and implementing interventions aimed at improving the quality and consis-tency of information exchange; (2) create and use summary client profiles such as PHPs to inform an appropriate care plan and to identify the potential for rehabilitation and service provision; (3) ensure that client information is comprehensive and meets the information needs of the different health professionals within the client's circle of care; and (4) educate health professionals in the benefits of using standardized assessments and EHIS for care planning and outcome measurement.

Consistent with recommendation 1 is how organizational structures benefit from the input and participation of organizational members (Boissy, Brière, Tousignant, & Rousseau, 2007; Vimarlund et al., 2008). The benefits of participating in a consultative process are on-the-job training, enhanced understanding of the needs of the organization, and the involvement of members in a learning process that lends itself to greater information sharing and communication within the team (Vimarlund et al., 2008).

The context of home care is changing with the adoption of new models of care, including a population-based/specialized model used in CCACs. This change in care delivery and practice philosophy enables a deeper, more focused understanding of client populations, their care-givers, and their care needs (Falode, Raymond, Sheehy, & Wise, 2011). While models of care are changing and evolving, so too are the uses of e-health systems. For instance, implementation of the IAR allows autho-rized users to work in collaboration with other care providers to effec-tively plan and deliver services (CCIM, 2010). Recommendation 2 con-cerns the potential for generating and using abstracted summary

information from standardized assessment tools (thus ensuring that it is tailored to the needs of the recipient) (Vaidya et al., 2012). The RAI-HC can be used to abstract specific summary information, which can then be transferred to health-care providers using the client's PHP. It is important that the different information-sharing systems and the content of the exchange be tested with a variety of home care professionals and that their possible impact on outcomes and quality indicators be understood. The client experience can be greatly improved through effective implementation and use of EHIS (Change Foundation, 2011b), with benefits for providers and clients alike.

The development and implementation of new models and approaches to care introduce the potential for changing roles and responsibilities and for improving access to health information. Even though these approaches are aimed at reducing inefficiencies in the system by enhancing the integration of care, attention needs to be given to keeping the client at the centre of care and using standardized assessments to generate a common language among home care professionals.

Our findings highlight policy issues and organizational structures that impede the sharing and use of health information. Our analyses of the survey results confirm that the list of barriers and facilitators largely reflects the perspectives of home care professionals. The findings suggest possible differences in information needs based on the roles and responsibilities of home care professionals and the model of care guiding assessments and care delivery. Thus, to facilitate the effective use of information collected using standardized assessment tools such as the RAI-HC, summary information (e.g., PHPs) may need to be tailored according to when providers enter the client's circle of care, providers' respective roles and responsibilities, and the purposes of the information being communicated.

As stated in recommendation 3, abundant information is being collected about clients' needs, health status, and functional abilities. The role of policy-makers is to ensure that clients' privacy is protected. A current issue with the use of EHIS is the question of when a health-care provider enters a client's circle of care and when he or she should have access to the client's records. While this issue is being considered, other issues of point-of-care and cross-sectoral access are also being discussed, as are the benefits of clinical decision-making and the quality of care (Vaidya et al., 2012).

The recommendations presented here are one step in addressing the barriers to and facilitators of sharing health information in home care, with the goal of improved home care rehabilitation. Evaluation of initiatives such as the PHP (derived from EHIS and electronic health records) and the IAR will be conducted in a subsequent phase of the research in

order to improve the context of home care rehabilitation for older adults with complex medical needs.

Recommendation 4 concerns the education of health professionals in the use of EHIS for care planning and outcomes measurement and in client advocacy (e.g., more resources or longer interventions if justified by aggregate person-level data). Databases that include all recipients of care can provide important evidence for prognosis and response to interventions. This is especially critical for rare or complex conditions that would not be included in randomized clinical trials. Training within professional clinical programs such as nursing will help us to understand different assessment systems and their applications. Research is also needed in working across health-care disciplines, to determine what information is needed to improve the delivery of home care services to clients across Canada.

The dialogue resulting from this study is a first step in understanding the information needs of health professionals working in home care. The sharing of information across disciplines also offers advantages outside of each profession, creating a system of client-centred care that is more efficient and that ensures improved continuity for the patient.

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Résumé

Analyse critique de la formation infirmière en ligne : à la recherche d'un équilibre entre optimisme et prudence

Marjorie McIntyre, Carol McDonald, Louise Racine

Le paysage de la formation infirmière s'est transformé sous l'impulsion d'une demande croissante de la part des étudiants à l'égard de cours en ligne, auquel s'ajoutent les directives vigoureuses des établissements concernant la prestation de cours par l'apprentissage distribué. Les auteures présentent un projet de recherche qualitative ancrée dans la philosophie herméneutique, dans le cadre duquel 30 étudiantes de premier cycle et des cycles supérieurs ont discuté de la dynamique des relations entre pairs et de son influence sur l'apprentissage en ligne. Parmi les conclusions, citons : les questions relatives au temps; les exigences de la participation en ligne; les expériences conflictuelles; l'acquisition de compétences dans un environnement virtuel. Les auteures examinent des questions théoriques relatives aux études telles que l'instrumentalité et la tensionalité, faisant ressortir des perspectives optimistes quant à l'apprentissage en ligne, mais aussi des éléments qui incitent à la prudence. Les étudiants qui suivent des cours en ligne pourraient bénéficier d'une orientation en face à face; on doit aussi privilégier le développement de communautés intellectuelles et sociales, un effectif de classe réduit et des occasions pour les apprenants d'entrer en relation les uns avec les autres.

Mots clés : formation infirmière, cours en ligne, apprentissage distribué, relations entre pairs, herméneutique

A Critical Analysis of Online Nursing Education: Balancing Optimistic and Cautionary Perspectives

Marjorie McIntyre, Carol McDonald, Louise Racine

The landscape of nursing education has been transformed by increasing student demand for online programs coupled with strong institutional directives to deliver nursing courses through distributed learning. The authors present a qualitative research design informed by philosophical hermeneutics in which 30 undergraduate and graduate nursing students discuss their experiences of the influence of peer dynamics on online learning. The findings include issues related to time, demands of online participation, experiences of conflict, and the development of skills in the online environment. Theoretical matters of curriculum such as instrumentality and tensionality are examined, generating both optimistic and cautionary possibilities for online learning. Online nursing students could benefit from a period of face-to-face orientation with a focus on building intellectual and social communities, limited class size, and opportunities to connect learners.

Keywords: distance education, informatics, nursing education, technology

Over the past 5 years the landscape of nursing education has been transformed by increased student demand for online programs coupled with strong institutional directives to deliver nursing courses through distributed learning (Holtslander, Racine, Furniss, Burles, & Turner, 2012; Wickersham & McElhany, 2010). Multiple factors contribute to this institutional push towards the use of information communication technology (ICT) to deliver nursing and health-care education. Some scholars argue that distributed learning models and online learning are necessary for universities to maintain their competitive edge in the face of the exponential growth of distance education in recent years (Matheos & Archer, 2004; Schulte, 2010).

For some educators, technology is *the* way to educate students in the 21st century. Jacques Attali has suggested that "the impact of information technology (IT) will be even more radical than the harnessing of steam and electricity in the 19th century" (cited in Duderstadt, 2000, p. 236). The desire to satisfy a technologically savvy generation of students, the

need to provide learner-centred education, collaborative learning, and simulation experiences that may palliate for the decreased number of "real" clinical placements (Comer, 2005; Hillenburg et al., 2006; Nguyen, Zierler, & Nguyen, 2011; Parsh, 2010) are among the forces driving the implementation of e-learning in nursing (Salyers, Carter, Barrett, & Williams, 2010; Smith, Passmore, & Faught, 2009). Furthermore, the need to make higher education accessible to those residing outside of major urban centres is often cited in support of the development of e-learning programs in nursing (Gunga & Ricketts, 2008; Tempelhof, Garman, Langman, & Adams, 2009) and other health disciplines (Hillenburg et al., 2006; Tempelhof et al., 2009).

As early as 1989 Graves and Cocoran defined nursing informatics as 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, p. 227). Here, we address informatics as programs and courses in nursing delivered through e-learning or ICT. The discussion draws on a qualitative study in which we interviewed graduates of two online nursing programs to gain an understanding of their experiences during their online education. Building on this study, we use the theoretical work of Hans Georg Gadamer (1998) and the eminent Canadian curriculum scholar Ted Aoki (Pinar & Irwin, 2005), as well as that of the nursing scholars Bevis and Watson (1989) and Patricia Benner (Benner, Sutphen, Leonard, & Day, 2010), to raise questions about both the utility and the challenges of technology as it aligns with nursing curriculum. After exploring some assumptions about technology and nursing education, we present a forecast for the future, generating both an optimistic view and a more cautionary assessment. The article ends with recommendations for nursing education and further research.

Clarification of Concepts

Before entering the core of the discussion, we should define some concepts arising from or re-labelled during the digital revolution. Ally (2004) points out that different terms have been used with reference to e-learning, noting that "e-learning, Internet learning, distributed learning, virtual learning, computer-assisted learning (CAL), Web-based learning and distance learning have been used somewhat interchangeably to refer to the use of Internet technology and of a computer to deliver education" (p. 4). In this article *e-learning* is interpreted as "the use of the Internet to access learning materials; to interact with the content, instructor, and other learners" (Ally, 2004, p. 5).

While some scholars have differentiated between the terms "distance education" and "distributed learning," others use them interchangeably. Matheos and Archer (2004), for example, note that distributed learning includes all of what had been traditionally referred to as distance education, most particularly asynchronous modes of delivery, but with the inclusion of on-campus formal learning activities. Similarly, Bates (2000) suggests that distributed learning combines many of the most advanced forms of distance learning technologies with aspects of traditional face-to-face education. Other scholars highlight the fact that distributed learning represents an instructional mode in which teachers, students, and content can be located in different places, allowing for teaching and learning to occur independently of time and setting (Saltzberg & Polyson, 1995). Teachers become facilitators of learning and students are required to become active participants in the learning process. The Web and computers become the medium through which learners and educators interact (Ally, 2004; Gunga & Ricketts, 2008).

One further concept used in this article, *digital revolution,* refers to the use of many ICT tools: podcasts, personal digital assistants (PDAs), smartphones (mobile learning, or m-learning), social networks (e.g., Facebook, Twitter), and CAL. These tools support e-learning whether delivered through distributed or onsite (face-to-face) models.

Assumptions of the Authors

There is no doubt that the digital revolution has impacted nursing education and will continue to do so. Though far from rejecting the opportunities offered by the digital revolution and distributed learning models, we challenge the assumption that educators and academic units should uncritically embrace technology as a dominant pedagogical approach to advance nursing education. We question this overarching assumption, that technology affords advancement or improvement, by examining the fit between nursing curriculum and technology. This article reveals, in a discussion of a research study, that, instead of unequivocally supporting or rejecting e-learning, educators must hold in tension the competing demands of curriculum and its mode of delivery. What follows is a presentation of the study, conducted by two of the authors, that informs this discussion.

The Study

Purpose

The research question — *How do peer dynamics influence student learning in an online environment?* — was addressed through a qualitative research design informed by philosophical hermeneutics (Gadamer, 1998). The

intention of a hermeneutic approach to inquiry is to generate new understandings, in this case about students' experiences of e-learning. The purpose of this work, as an interpretative inquiry, is neither to be conclusive nor to provide closure to a topic. Rather, the approach generates accounts that are interpreted alongside what is already known, using an iterative process. The interpretation can be used to challenge the assumptions that influence practice — in this case, teaching and learning online. As we discuss the approach and implementation of the research, we will address the sample (the participants), ethics review, and data generation and analysis. We will then present the findings and offer a discussion of the findings.

Participants

Participants were drawn from among graduates of two online programs at a school of nursing. Those eligible had graduated within the previous 2 years from the post-diploma bachelor of nursing program or within the previous 5 years from the master of nursing program. They were contacted by e-mail and invited to speak with the research assistant, who then arranged for the interview. A total of 30 graduates from the two programs took part in interviews either via telephone or face-to-face. The interviews, which varied from 30 to 90 minutes in duration, were audiorecorded, transcribed, and interpreted by the research team. Written informed consent to be interviewed and recorded was obtained from the nurses prior to their participation in the study.

Ethics Review

Approval was obtained from the University Ethical Review of Human Subjects Committee prior to the study. Ethical concerns that were addressed include written informed consent by participants in interviews and focus groups, confidentiality of the data (audiorecordings and transcriptions were locked in a filing cabinet), and the use of pseudonyms to conceal participants' identities. Considerable attention was given to the possibility of conflation of the dual role of teacher and researcher. To circumvent this possibility and to further ensure anonymity, we arranged for the interviews to be conducted only by team members who were not teaching in the graduate program. For similar reasons, the focus group facilitator was hired external to the research team and the graduate program. Interviewers presented participants with the idea of ongoing consent, whereby their continued consent would be sought throughout the process.

Data Generation

In keeping with the hermeneutic approach, data were generated through conversations to be interpreted by the research team. Conversations took

place in one-to-one unstructured interviews, in a focus group, and in researchers' reflections recorded in journals. Here, we use the word "conversation" to signify the co-construction of interactions in this generative process.

Interviews. During the interviews, the participants were invited to explore their experience of the influence of peer dynamics on online learning. The purpose of questioning in hermeneutic inquiry is to stimulate reflection and deeper exploration of the experience (McIntyre, 2003). It was anticipated that the interviewee would move beyond a description of the experience, to reflect on its meaning. In this way, space would be opened up during the interview for new understandings and interpretations of how peer dynamics influence student learning in an online environment. In the hermeneutic approach, each interview is unstructured, inasmuch as the interviewer remains open to whatever the participant might like to say about the topic under discussion. In our case, however, the interviews began with an explanation of our wish to understand how student learning is influenced by peer dynamics. For example, the interviewer might state, "The researchers are interested in the experience of online learning from the perspective of graduates of a program offered solely online. In particular, we are interested in hearing about how peer dynamics influenced your online learning experience."

Focus group. Eight people participated in a focus group, which was similarly audiorecorded, transcribed, and interpreted. The focus group participants had an opportunity to consider their thoughts in the context of the responses of others. This process is viewed as an extension of data collection rather than as a validation of the interview data (Patton, 2002).

Journals. The interviewers made field notes following each encounter with participants, and researchers used a reflexive journal to document observations and thoughts that arose during the research process (Kvale, 1996). The journaling continued throughout the interpretative process when all the researchers met as a group to review, discuss, write about, and interpret the texts of the research conversations.

Data Analysis

There is widespread acceptance of the idea that in hermeneutic research the analysis process begins with the first interview and continues through subsequent interviews, the team discussions, and the writing. Each instance is considered for what it contributes to our understanding of the experience as a whole. As ideas are shared, new understandings are generated and new possibilities open up for — in this particular case — how we understand the way in which the peer dynamic influences online learning, how we understand what students have to say on the topic, and how we understand ourselves as educators.

Hermeneutic inquiry is iterative; the metaphor of the hermeneutic circle is often used to describe the tracing and retracing of movement from part to whole: from what is being said in the interview, including the presuppositions of the researchers (the parts) to the multiple and new understandings being generated (the whole) (Gadamer, 1998). This movement also occurs during the interviews, with participants being encouraged to reflect on the thoughts, feelings, and responses that arise. In keeping with the interpretive process, the interview transcripts were revisited alongside the focus group transcripts.

Findings

The iterative process of hermeneutic data analysis results in interpretations that speak to the research conversations but are not intended, in an ontic sense, to represent them (Heidegger, 1953). Thus, in this study the interpretive findings generated understandings of the influence of peer dynamics on student learning without describing the experience. We will now discuss the topics that emerged and re-emerged throughout the interpretive process of engaging in the interviews, focus group, and researchers' journal notes.

It's About Time

Time was the topic that surfaced most often during the interviews. Many participants expressed an initial belief that online learning would provide them with more flexible access to education, in terms of time. The words of one participant describe the sentiments of many:

> I was able to work around my full-time job and my child-raising and my other responsibilities, so that was a big part of the decision [to enrol in the online program].

Participants explained that they had initially mistakenly conflated the convenience of access to online courses with a more manageable workload. They found that developing the resilient peer relationships needed to support student learning required more commitment and more continuous effort in an online environment than it might in a face-to-face environment. Further, many participants assumed that their online studies could be added, without complication, to a full schedule of work, parenting, and personal commitments. Participants were challenged by the reality that students had different amounts of time available for course work, which influenced one's learning as part of a peer group. For example, participants reported that some of their classmates were not employed and could attend to their course work full-time whereas others might be working full-time and fitting the course work in where they

could. Some students had major family responsibilities whereas for others their studies were a clear priority. Although for the most part these situational differences were well understood by the students, when group assignments were due or when people did not come online when they were expected to, it became challenging for participants to maintain the good will needed and often conflicts arose. Additionally, participants spoke about different response times among classmates, which was problematic for many.

Participants reported a vast array of online behaviours by classmates, with some finding the time to come online every day and to respond promptly and others not responding even to direct requests for contact. The discussions about time included many positive comments about the development of participants' time-management skills over the duration of their online studies. Closely connected to the idea of time was the expressed ambiguity about the seemingly unending opportunities/expectations for online participation.

Demands of Online Participation

When comparing online and face-to-face classroom experiences, participants noted that in the latter the class schedule provided a structure to pace student participation. Although participants cited the flexibility of course access as a strength of asynchronous online studies, they also expressed a wish for boundaries or containment to participation. The absence of structure was particularly problematic in courses in which the whole of the course material was available to students at the beginning of the course. In this situation, when students were expected to engage in peer discussion yet could work at their own pace, meaningful engagement was challenged:

> I recall a couple of experiences where I was at a very different place [in the course material] than where the other students were at, and then dialogue online became actually quite meaningless, because it was just not in the right place at the right time.

This issue was expressed as a lack of continuity in peer engagement: "discontinuity . . . lack of a peer cohort . . . feeling isolated . . . left to my own devices." For this person, there was a "troubling lack of structure." It became very clear from the accounts that over-participation (moving ahead regardless of where the group was at) was as problematic as under-participation (where students would not come online in a timely manner, thus undermining the work of their classmates).

Participants expressed different ideas about the ideal amount of online interaction with their peers. They had different needs for contact with peers at various times in their courses and programs. Some spoke of the

online learning environment as isolating and lonely, wishing for more connection with classmates, while at the same time acknowledging that they had neither the desire nor the space in their lives for new social relationships. Participants expressed a simultaneous wish to better know their classmates personally and a sense of being overwhelmed by too many e-mail contacts with classmates. One participant expressed this situation as a "desire for connection . . . the space for community to develop . . . time for conversations to happen in the moment."

Experiences of Conflict

Frequently brought up in the interviews were instances of conflict between students, which influenced the peer dynamic and subsequent opportunities for learning. Many instances of conflict arose in response to different expectations of participation, while other — often more serious — conflicts resulted from differences in beliefs and values. A commonly identified source of conflict was the course requirement that students take part in online group work, particularly graded projects or assignments. While in a face-to-face classroom situation arrangements can easily be made to work in groups, these students faced what in their view were the underestimated difficulties of connecting electronically with peers across time zones and vast geographies. Participants said that the limitations of electronic media made it difficult for students to get to know one other, which sometimes led to misunderstandings. For example, one participant spoke of feeling very frustrated with a classmate because of her online communication style, which changed dramatically when the participant had the opportunity to meet this classmate in person.

Despite the difficulties caused by these conflicts during their course work, participants felt they had learned from them and in some cases could transfer the lessons learned to similar challenges in their professional practice. One woman commented that her online learning experience made her realize that she "could have an impact on my own learning environment." Initially she blamed faculty for "not directing or containing the conversations" in which conflict was brewing, but with time she saw herself as "an agent in changing some of the class dynamics" and eventually described herself as a mentor to other online learners.

Developing Skills in the Online Environment

Participants reported that some of the most challenging difficulties of peer communication were resolved as they developed skills relevant to online learning. Specifically, increased skills and confidence in online writing and group facilitation led to positive experiences within and across courses. Participants spoke of how their use of digital technology

to communicate with classmates improved to the point where they realized they had the ability to assist others with the technology, not only in the online learning environment but also in the workplace. What had begun as a major obstacle was now looked upon as developing skills that were becoming increasingly important in their lives.

A similar instance of skill development was online writing. Several distinct issues emerged in the discussions about online writing. Many participants spoke of feeling intimidated and vulnerable posting their ideas in writing due to uncertainty about who would have access to the posting, its apparent permanence, and how it would be interpreted by others. The visual display of their thoughts or ideas was experienced quite differently from an oral discussion in a face-to-face classroom setting. For some this vulnerability receded as the course progressed but for others it did not. As the course work advanced, participants experienced a shift; they felt privileged to be able to see the writing of others and came to appreciate how their own scholarship was influenced by how others expressed their perspectives on the same topic. Online postings presented opportunities to see classmates' writing, which had not been a feature of the participants' face-to-face classroom learning. They were able to see how their peers developed their ideas and repeatedly stated how impressed they were by this.

Several participants gave examples of how their writing ability continued to serve them in their professional practice and expressed appreciation for the opportunity to develop this skill. For some, the ability to express themselves in writing and the technological proficiency they developed during the course opened up new opportunities in the workplace, allowing them to take a leadership position and speak out on practice issues:

> When I started doing my academic courses, writing papers and getting really positive feedback, that kind of spurred me on to think deeper and write more . . . It was through the writing that I started to find my voice. My confidence was increasing as a result of the feedback I was getting on my writing, and then that actually changed my practice — I think it changed my whole way of being . . . I found myself, pretty soon, in a situation where I was offering support and help [to my peers] and it made me think differently about myself.

Situating the Findings Within Theoretical Perspectives

These findings demonstrate that students engage in online courses with a priori assumptions about e-learning, such as the expectation that their experience in face-to-face courses will readily transfer to the online

format. Throughout the study, participants made comparisons between the two very different learning and teaching formats. In many cases the unreasonableness of their expectations of peer relationships resulted from the complexities of online learning and the limitations on what can be accomplished in this format. We are struck by how the participants' decision to take online courses, as well as what they experienced as challenges to learning, can be readily connected to matters of instrumentality.

The Thread of Instrumentality

One can think of instrumental reasoning as detachment from the particulars of the subjectivity of the people involved, in this case students and teachers, and from the situation in which learning takes place. Aoki (Pinar & Irwin, 2005), drawing on the work of Gadamer (1998), suggests that there are several ways that instrumental reasoning can influence how we understand a situation. For example, the idea that the means justifies the ends can be seen when students, teachers, or administrators make decisions about e-learning for other than pedagogical reasons. In instrumentalism, curriculum is viewed as information to be consumed or applied, rather than as the exchange of knowledge by people in particular situations — as a linear focus on cause and effect, rather than as the complexity of lives in which learning and professional practice are situated.

Computer technology, particularly e-learning programs (including the unpredictability of computers and Internet connections), and the associated requisite skills to engage with technology, create an endless combination of circumstances for each student that either hinder or promote engagement with learning. While it is easy to see that those instrumental concerns related to e-learning technology are not the focus of nursing education, it is not so easy to dismiss the imperious presence of instrumentality in the participants' conversations.

Furthermore, an argument can be made that it is instrumental reasoning that underpins the advantages of e-learning for academic institutions as well. Online classes and e-learning can be seen as instrumental solutions to the institutional challenge of managing increased enrolment with fewer resources. Not only does e-learning manage classes without classrooms, but class sizes can be increased without competition for space. The implications for education are considerable, however, as class size influences the establishment of learning communities (McDowell, Trunzo, & Vincent, 2005). We will now embark on a discussion of the tensions with instrumentality, including the purpose of the university and the nursing curriculum.

Tensionality in Online Nursing Education

The reader may be familiar with the notion of tensions as residing between two competing interests or ideas, where the aim is to have one

position become dominant, resolving or releasing the tension. In this case, however, the discussion draws on the work of Aoki, for whom tensionality is a place of "indwelling" between two horizons where the quality of the lived life of the educator relies on holding, rather than overcoming, the tensionality. Aoki understands this "indwelling in tensionality" as part of being a teacher, and he reminds us that "to be alive is to live in tension; it is in fact the tensionality that allows good thoughts and actions to arise when properly tensioned chords are struck" (Pinar & Irwin, 2005, p. 162). While in this example Aoki is referring to the tensionality between curriculum as plan and curriculum as lived, we suggest that this is also salient for the tension between the demands of instrumentalism of technology and engagement with the nursing curriculum through e-learning. Furthering Aoki's particular discussion of the *teacher* as living the tension between curriculum as plan and curriculum as lived, we draw on both Aoki's notion and that of Bevis and Watson (1989), who see curriculum as "the interactions and transactions that occur between and among students and teachers with the intent that learning occur" (p. 5). The nursing curriculum, which encompasses the relationships between teacher, learner, and content, is expanded and, some might say, strained by the additional instrumental demands and relational restrictions imposed by online e-learning. This is not to suggest that the delivery of all nursing education via e-learning is steeped in instrumentalism. However, we commonly see, in situations where the curriculum content is predetermined and delivered online, or where the courses are viewed as "commodities to be dispensed by teachers and . . . consumed by students" (Pinar & Irwin, 2005, p. 118), that instrumental action is at play.

Aoki critiques the instrumental implementation of curriculum with the claim that "instrumental action is not the way the world is . . . the instrumental view of implementation minimizes or neglects the interpretive activities" (Pinar & Irwin, 2005, p. 115), the subjectivity of the teacher and students as they engage with curriculum. We add that instrumental action is antithetical to the relational aspects of nursing practice, wherein general knowledge is related to the particularity of people in context, considering the subjectivity of both the patient and the nurse.

Generating Possibilities for Holding the Tension: The Optimistic Perspective

There is growing evidence that online delivery increases access to nursing education, most notably among nurses residing in remote and rural areas in Canada (Andrews et al., 2005; Andrusyszyn, Cragg, & Humbert, 2001; Penz et al., 2007; Tilleczek, Pong, & Caty, 2005). Consistent with findings reported in the literature, our participants identified accessibility of continuing and graduate education as a significant advantage of online learn-

ing. The value of access to nursing education should not be underrated, in light of the shortage of practising nurses, nurse leaders, and nurse educators (Benner et al., 2010, p. 3). Chueng and Aiken (2006) make a link between the shortage of nurses at all levels and the quality of health-care delivery. Furthermore, the reality of increasingly limited funding to support graduate education, coupled with the need for employment to sustain economic stability in families, means that for many nurses the only educational opportunities are online programs.

Additionally, one can be optimistic about the development of online skills, including scholarship, writing, facilitation, and technological skills, which are being increasingly valued as computer technology becomes a more integral part of professional nursing and health-care practice.

Portability is another advantage of digital technology. For example, m-learning relies on the use of mobile devices like smartphones, PDAs, tablets, and notebooks to increase the portability of learning (Bassendowski, 2009). Kristine Peters (as cited in Bassendowski, 2009) underscores the idea that these devices provide "just enough, just in time, just for me" (p. 1) to satisfy a generation of technologically savvy nursing students. Bassendowski asserts that "mobile services are being marketed as very efficient teaching and learning tools" and "mobile learning can enhance and support more traditional teaching and learning modes" (p. 1).

Balancing the Tension: A Cautionary Perspective

As much as the advantages and opportunities of the digital revolution cannot be overlooked, some authors take a cautionary approach to counterbalance the optimistic perspective. Uncritical acceptance of the digital revolution relies on some problematic assumptions — for example, the conflation of knowledge and information (Pinar & Irwin, 2005); an overemphasis on the mastery of technical skills at the expense of the cognitive, social, and emotional skills necessary for learning (Hillenburg et al., 2006); the development of intellectual capacities (Walker, 1997); and the development of a social consciousness that supports praxis and emancipatory knowledge (Kagan, Smith, Cowling, & Chinn, 2009). Although technical knowledge is mandatory for practice, a narrow emphasis on its mastery may lead to social and disciplinary conformism. An overemphasis on technical knowledge may hinder the advancement of nursing in feeding an already strong anti-intellectualist current. Anti-intellectualism has been described in scholarly work both in nursing and in education (Duff, 2005; Gunga & Ricketts, 2008; Holmes, 2002; Miers, 2002; Walker, 1997). More disturbing is the fact, pointed out by Myrick (2004), that "the original purpose of a university education was . . . to foster a desire for right conduct and good things which ultimately cannot be neatly

packaged and delivered" (p. 23). Contemporary, 21st-century practice requires nurses to address issues of equity, diversity, gender, social justice, class and race discrimination, and Othering that influence the delivery of nursing care (Davidson, Meleis, Daly, & Douglas, 2003). In addition, the impact of globalization and neoliberal economic policies on population health and the need for nurses to achieve the social mission of the nursing discipline may be overlooked if the goal of nursing education is limited to supplying the labour market. Students must be equipped with the skills and knowledge necessary for them to become socially conscious nurses and educated global citizens (Falk-Rafael, 2005; Kagan et al., 2009; Proctor et al., 2010; Racine, Proctor, & Jewell, 2012). The complexity of nursing practice calls for an examination of the assumptions underlying the cautionary argument as presented by some scholars in nursing and in education.

Recommendations

In this article we have presented a discussion of e-learning drawing on a hermeneutic study of students' online learning experiences and situated in the context of theoretical perspectives and the literature on online learning. Arising from this discussion are two possibilities for holding the tension of online learning in nursing education. As we have seen, hermeneutics does not lead to conclusions, nor does it lend itself to verifiable recommendations. The interpretive process is an ongoing one of bringing new understandings to bear on what is already known. We encourage the reader to embrace these recommendations as new understandings and to join in the interpretive endeavour.

Our findings make it clear that the expectations of both students and educators, developed in a face-to-face (onsite) learning environment, do not transfer easily to an online e-learning format. Students, for example, sometimes conflate the ease of access to online learning with a more manageable workload. Numerous participants discussed unmet expectations for peer relations. Additionally, participants reported significant challenges and conflicts related to issues of frequency and timing of participation and required group work.

Given these ongoing challenges in online learning, we recommend the development of structures that take into account the particular nature of the online environment. We suggest that programs be structured such that students move through courses together as a cohort, facilitating the development of a learning community. The peer contribution to learning is also fostered when courses are structured in a way that paces or contains student participation. While group work can be a valuable learning opportunity for students, the online environment brings additional chal-

lenges to this endeavour, particularly when students are working across time zones.

Since completing the study, we have had the opportunity to implement an onsite, face-to-face orientation for students in the online master of nursing program. This required orientation focuses on building intellectual and social communities, appraising and upgrading writing skills, and, where needed, practising technological skills that support student learning. Strategies to connect students to peers in their geographic locations, areas of practice, and even areas of personal interest can be easily integrated into onsite orientation sessions. With a deliberate focus on the influence of peer dynamics, education in the online format provides opportunities for students to develop their own intellectual and professional capacities and, through mentorship, to provide support and leadership to their peers.

In addition to such strategies, educators are encouraged to resist the convenience and security of pre-established course packages and engage with students spontaneously and individually. While attention to what we have critiqued as instrumental issues is necessary, embracing the subjectivity of teachers and learners is central to the success of all learning. The curriculum of the online classroom, as with the face-to-face classroom, relies on interaction between students, teacher, and content; however, the context of e-learning changes the situatedness of all those involved. Therefore, teachers and administrators cannot assume that teaching approaches will transfer across these contexts; faculty development for the online learning and teaching environment is imperative.

In summary, the digital revolution is a fact of 21st-century nursing education. The issue resides not in whether to adopt e-learning but, rather, in determining how the digital revolution and e-learning can best contribute to nursing education.

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Résumé

Une évaluation formative de l'usage des appareils électroniques par les infirmières dans un contexte de soins à domicile

Diane M. Doran, Cheryl Reid-Haughian, Autumn Chilcote, Yu Qing (Chris) Bai

Notre étude avait pour but d'évaluer l'implantation d'un système d'information clinique (SIC) dans un cadre communautaire. Les chercheurs ont établi une méthodologie mixte composée d'entrevues, de groupes de discussion et d'enquêtes. On a interrogé un échantillon transversal indépendant composé d'infirmières. En tout, 118 infirmières ont répondu à l'instant 1 et 81 infirmières à l'instant 2 ultérieur. Les répondantes étaient modérément satisfaites des caractéristiques du SIC. Dans le premier groupe, on relève un lien positif entre la satisfaction des usagers, l'accès aux ressources structurelles et électroniques et le capital social, et un lien négatif avec l'âge des infirmières; dans le deuxième, un lien positif entre le capital social et la satisfaction des usagers. Dans les deux groupes, on relève un lien entre la jeunesse et l'utilisation de la recherche. On constate un lien négatif entre l'application de la recherche et l'évaluation et le retour, mais un lien positif avec les interactions formelles. Notre évaluation fait ressortir l'importance du soutien éducatif, d'une conception axée sur l'usager et du degré d'intérêt pour la mise en œuvre réussie d'un SIC dans un cadre communautaire.

Mots clés : système d'information clinique, appareils électroniques, soins à domicile, utilisation de la recherche

A Formative Evaluation of Nurses' Use of Electronic Devices in a Home Care Setting

Diane M. Doran, Cheryl Reid-Haughian, Autumn Chilcote, Yu Qing (Chris) Bai

The purpose of this study was to evaluate the implementation of a clinical information system (CIS) in a community setting. The researchers used a mixed-method design involving interviews, focus groups, and surveys. An independent cross-sectional sample of nurses was surveyed. At time 1 a total of 118 nurses responded and at time 2 a total of 81. Respondents were moderately satisfied with features of the CIS. User satisfaction was positively associated with access to structural and electronic resources and social capital and negatively associated with nurses' age at time 1. Social capital was positively associated with user satisfaction at time 2. Younger age was associated with overall research use at both time 1 and time 2. Research use was negatively associated with evaluation and feedback but positively associated with formal interactions. This evaluation identified the importance of educational support, user-centred design, and responsiveness to successful implementation of CISs in a community setting.

Keywords: community health nursing, informatics, research utilization/ evidenced-based practice, technology

Introduction

With the transition of nursing practice from the traditional framework of experiential and intuitive knowledge to an evidence-informed framework, the quantity and quality of evidence-based resources, such as practice guidelines, have markedly increased (Protti, 2008). The literature highlights the benefits to nursing and patient outcomes of the best available research evidence to support clinical decisions (Estabrooks, 2003; Estabrooks, Floyd, Scott-Findlay, O'Leary, & Gushta, 2003; MacIntosh-Murray & Choo, 2005). Decision aids, such as screening and assessment tools, can support evidence-based practice (Randell, Mitchell, Thompson, McCaughan, & Dowding, 2009), but for many nurses the utilization of evidence-based resources in decision-making remains a challenge.

An essential feature of information management is ensuring that the information is accessible at the time of decision-making. In nursing, this imperative has been constrained by limited access to evidence-based guidelines at the point of care. Information technologies such as personal

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digital assistants (PDAs) and handheld computers (tablets) offer solutions for getting evidence to nurses directly at the point of care. Recognition of PDAs as a valuable information tool in nursing practice is relatively recent (Garrett & Klein, 2008; Honeybourne, Sutton, & Ward, 2006; Stroud, Smith, & Erkel, 2009). Research suggests that handheld technology can promote timely communication, enable evidence-based practice, and streamline patient care by capturing clinical data (Doran et al., 2010; Hardwick, Pulido, & Adelson, 2007).

Much of the research related to electronic information systems reports completion rates or workload percentages, with limited feedback from frontline users (Poissant, Perfeira, Tamblyn, & Kawasumi, 2005). There are gaps in the literature related to when and how nurses use evidence-based information to inform their clinical decisions and how decision-support systems can be designed to support nurses' clinical workflow. Moreover, the unique decentralized environment of home care nursing requires an enhanced implementation and integration strategy.

This article reports on the formative evaluation of a clinical documentation system for community nursing, focusing on integration of standardized assessment tools into clinical documentation and incorporation of evidence-based practice resources. For the evaluation, community nurses were provided access to clinical documentation, evidence-based resources through BlackBerry devices, e-mail, and a secure portal. Nurses documented patient outcomes using standardized outcome measures developed by the Health Outcomes for Better Information and Care (HOBIC) program. They had access to two Internet resources: the Registered Nurses Association of Ontario (RNAO) Best Practice Guidelines (Registered Nurses Association of Ontario [RNAO], 2011) and the McMaster University Nursing Plus library (Health Information Research Unit, 2008).

HOBIC is funded by the Ontario government (Pringle & White, 2002). The outcomes data (e.g., symptoms, therapeutic self-care) are collected electronically when nurses complete patient assessments and are used by nurses to monitor the impact of care and to ensure, for example, that patients are prepared for discharge. The RNAO launched the nursing Best Practice Guidelines program in 1999, with funding from the Ontario Ministry of Health and Long-Term Care (RNAO, 2011). The guidelines have been adapted for PDAs and smartphones. There is evidence that their use results in improved outcomes (Prentice et al., 2009). Nursing Plus Best Evidence for Nursing Care from McMaster University's Health Information Research Unit allows nurses to register their areas of clinical interest in order to receive e-mail alerts about publication abstracts relevant to those areas. Nurses have access to a searchable database of the best evidence from the medical literature, an e-mail

alerting system, and links to selected evidence-based resources (http://www.caretoknow.org/link/nursing-plus-best-evidence-nursing-care).

Purpose of the Study

The purpose of the study was to evaluate the implementation of an auto-mated clinical information system (CIS) in a community setting. The CIS enables nurses to document admission assessments, discharge assessments, and client re-assessments when there is a clinical change. Nurses also doc-ument administrative data such as visit information for scheduling, billing, and payroll purposes. In addition, the CIS provides nurses with access to the evidence-based resources described above. The study inves-tigated nurses' perceptions of barriers to and facilitators of adoption of the CIS and evaluated changes in organizational context and evidence-based practice over time.

Literature Review

A review of the literature on the use of electronic health information systems in home care found that the top three facilitators for the use of information systems were portable technology, strategies for decreasing data-entry errors, and managerial support during implementation (Stolee, Steeves, Glenny, & Filsinger, 2010). Another literature review concluded that computer experience, system design, and system performance, such as speed, were the primary factors influencing nurses' attitudes towards health-care information technology (Huryk, 2010). A survey of registered nurses in the state of Ohio found that computer experience, user involvement, and nursing-management support significantly explained information system use (Abdrbo, Hudak, Anthony, & Douglas, 2011).

A study with home care health workers in Sweden found that the non-intervention group improved in terms of documentation, whereas the intervention group showed a trend towards deterioration in docu-mentation; no benefits were observed with regard to staff satisfaction (Engstrom et al., 2009). In contrast, a Dutch study with nursing assistants and registered nurses in acute-care settings found that nursing staff asso-ciated electronic patient records with improved care (deVeer & Franke, 2010). A qualitative study examined the impact of PDAs on patient care (Honeybourne et al., 2006). The authors report that 11 of the 12 staff members reported a benefit of handheld systems in addressing immediate patient concerns. A key point in providing evidence at the point of care was the speed at which the information was delivered.

Qualitative research by Garrett and Klein (2008) explored the percep-tions of advanced practice nurses (APNs) on the value of wireless PDA technologies. APNs identified improved patient care as the major benefit

of PDA use. Clinical reference applications such as drug and diagnostic/laboratory reference applications and wireless communication were the tools that appeared to be most useful to the participants. Doran et al. (2010) report significant improvements regarding barriers to research utilization, quality of care, and job satisfaction for nurses who were provided access to information resources via PDAs. Our study was designed to advance this research by investigating changes in self-reported research utilization following the implementation of a CIS on BlackBerry devices.

Theoretical Perspective

The Staggers and Parks Nurse-Computer Interaction Framework served as a framework for studying facilitators of and barriers to nurse acceptance of the automated CIS (Staggers, Thompson, & Snyder-Halpern, 2001). The Staggers and Parks framework conceptualizes the nurse-computer interaction as a system of mutual influences that together promote adaptation to computerized documentation tasks. Successful adaptation is dependent on nurse characteristics, computer characteristics, and the context in which the nurse will be using the CIS. Nurse characteristics include flexibility in adapting to change, cognitive abilities, learning styles, attitudes towards computers, and computer experience (Whittaker, Aufdenkamp, & Tinley, 2009). Computer characteristics include types of hardware, screen displays, and software programs (Whittaker et al., 2009). User context is the environment in which the CIS is implemented and utilized.

The Promoting Action on Research Implementation in Health Services (PARiHS) model (Kitson, Harvey, & McCormack, 1998; Rycroft-Malone et al., 2004) provided the framework for studying the impact of context on nurses' use of the CIS and impact on evidence-based practice. The successful implementation of evidence is conceptualized as a function of the relationship between (a) the nature of the evidence; (b) the context in which practice change will occur (prevailing culture, leadership roles assigned, and measurement and feedback); and (c) the mechanisms by which the change is facilitated (Kitson et al., 1998; Rycroft-Malone et al., 2004). The PARiHS model was used to explain variation in nurses' research utilization in two recent Canadian studies. In the first, the largest proportion of variation in research utilization was explained by nurse-level variables; however, both specialty and hospital-level variables (i.e., context) contributed a small but significant proportion of the variance in research utilization (Estabrooks, Midodzi, Cummings, & Wallin, 2007). In another multilevel analysis of variables derived from the PARiHS model by the same group of researchers, hos-

pital characteristics that positively influenced nurses' research utilization were staff development, opportunity for nurse-to-nurse collaboration, and staffing and support services (Cummings, Estabrooks, Midodzi, Wallin, & Hayduk, 2007). Nurses working in contexts with more positive culture, leadership, and evaluation reported significantly more research utilization.

The present study had four objectives:

- Determine the usability of the CIS during the formative phase of implementation.
- Determine the extent to which nurses' clinical and organizational processes have been impacted by the implementation of the automated CIS.
- Assess how the organizational context — specifically, presence of electronic documentation, leadership, culture, opportunity for evaluation feedback, informal interactions, formal interactions, structural and electronic resources, and organizational resources or *slack* — changes over time as a result of the CIS implementation.
- Assess the effect of the CIS on evidence-based practice.

Methods

A CIS was designed collaboratively with nursing and health informatics experts and professional practice leaders within the agency. The CIS development included three distinct components: a comprehensive clinical assessment tool, an innovative portal system, and automated reporting. The CIS was designed to follow the nurse's workflow at the point of care through ease of navigation between system elements. HOBIC documentation was integrated into the system and allowed the nurse to review the impact of interventions on client outcomes. The application included auto-population functions where appropriate, decision support in the form of pop-up reminders, forced constraints, pick lists, and multi-select options, along with space for free text to document client narrative if desired. The portal includes *store-and-forward* technology to minimize barriers to using the device when the nurse is outside of network areas. The portal was designed as view-only, with the ability to enable internal and external access to the health-care team. An automated reporting feature for client outcome measures and key administrative reports was created. Updates and continuous improvements to the application were scheduled in response to feedback from nurses and clinical supervisors.

Design

A mixed-method design was used to collect data on the study variables. Qualitative descriptive methodology (Sandelowski, 2000, 2010), involving

semi-structured interviews and focus groups, was used to build a contextual understanding of barriers to and facilitators of automated CIS adoption and to determine how assessment tools and best practice evidence influence clinical decisions, why, and with what result. Surveys were used to collect quantitative data on nurses' satisfaction with features of the automated CIS, change in evidence-based practice, and change in organizational context over time.

A cross-sectional sample of nurses was surveyed and interviewed at two points: approximately 6 months after implementation (time 1) and approximately 18 later (time 2). The cross-sectional nature of the two samples meant that it was impossible to link time 1 and time 2 scores.

Approval for the study was obtained from the institutional research ethics review board of the university and the Community Care Access Centres. All participants gave written informed consent before the interview. Completion of surveys was anonymous.

Setting and Sample

The research was conducted at a home care provider agency in Canada. Home care nurses were given a BlackBerry device for use during clinical visits. A total of 118 nurses responded to the time 1 survey. Of these respondents, 71% (80) were registered nurses, 64.3% (72) worked in the staff/visiting nurse role, and the majority worked within the adult comprehensive home care program (57.1%). The majority of respondents were female (91.1%), diploma/certificate-prepared (65.2%), and worked part-time or casual hours (54.5%). The majority of respondents had used the application for 6 months or less (81.3%) and were using the system for only 4 to 10 hours per week (60.7%). Thus the time 1 respondents were novice users.

A total of 81 nurses responded to the time 2 survey. Of these, 69% (54) were registered nurses, 55.1% worked in the staff/visiting nurse role, and, similarly, the majority worked within the adult comprehensive home care program (77.8%). Approximately 95% were female, 67.1% were diploma/certificate-prepared, and 50.0% worked full-time. Of the respondents, 53% had used the application for more than 1 year at time 2.

Data Collection

Semi-structured interviews. Eleven semi-structured interviews were conducted with a stratified sample of staff nurses and supervisors from the home care agency, with the goal of delineating (1) barriers to and facilitators of CIS adaptation; (2) issues related to software and technology; (3) assessment-tool influences on clinical decisions; (4) where, within the

clinical workflow, information resources and best practice guidelines are needed or are most helpful; and (5) any constraints (e.g., time, technology) that inhibit nurses' ability to use the automated CIS. The interviews were conducted by telephone by a member of the research team trained in qualitative methods.

Focus groups. Five focus groups with supervisors and staff nurses were conducted at the start of time 2 to confirm qualitative themes from time 1 interviews and further define specific areas of interest or concern to CIS users. The focus groups were conducted by a member of the research team and were recorded for the purpose of data analysis. They were scheduled to coincide with regular supervisory and/or staff meetings.

Usability evaluation. An adaptation of the Questionnaire for User Interface Satisfaction (Norman, Slaughter, Schneiderman, & Harper, 1988) was used to collect data on nurses' satisfaction with features of the automated CIS and BlackBerry. Validity was established for the original questionnaire. Nurses were asked to rate their satisfaction with each of the resources on a nine-point scale, with positive adjectives (e.g., *satisfying*) anchoring the right end and negative adjectives (e.g., *frustrating*) anchoring the left. One item examined nurses' overall reaction to the system. Four items asked about characteristics of the device; six items asked about terminology; nine items asked about system capabilities, such as speed and network access; four items asked about ease of learning to use the system; and six items asked about teleconferencing support for new users.

Organizational context. The Alberta Context Tool (ACT), a 58-item instrument developed by Estabrooks and colleagues (Estabrooks, Squires, Cummings, Birdsell, & Norton, 2009), was used to measure features of the organizational context. The 58 items include variables of leadership (6 items); culture (6 items); feedback processes/evaluation (6 items); organizational resources (11 items); organizational slack, including time (4 items), space (3 items), and staffing (3 items); informal interactions (9 items); formal interactions (4 items); and social capital (6 items). Cronbach's alpha has been reported as ranging from 0.37 to 0.92 for a 10-concept version (Estabrooks, Squires, Hayduk, Cummings, & Norton, 2011). Construct validity was established with confirmatory factor analysis (Estabrooks et al., 2011). Cronbach's alpha for the 10-concept version used in this study ranged from 0.50 to 0.91.

Nurse variables. Data on nurse demographic characteristics, including education, experience, and professional designation, were collected through questionnaires. Data were collected on nurses' attitude towards research (items adapted by Estabrooks from Lacey [1994] with permission), and *belief suspension* (both components): willingness to use research (0.80) and implementation of research in practice, using items developed

by Estabrooks (1997). Cronbach's alpha ranged from 0.74 for "belief willing to implement research" at time 2 to 0.85 for "belief actually implement research" at time 2.

Data Analysis

Two-sided *t* test was used to compare the mean difference of subscale scores and study variables between time 1 and time 2. Two-tailed *p* values were computed based on *t* distribution under the null hypothesis (i.e., equal means). Regression analysis was employed to detect the associations between organizational context and research utilization and overall user reactions to the CIS. All statistical tests were performed at the 0.05 significance level. All quantitative data analyses were performed using Statistical Analysis Software (SAS) 9.3. A multilayered content analysis of qualitative data from interviews and focus groups was conducted using NVivo 8 qualitative-analysis software. Responses to open-ended interview and focus group prompts were coded into main ideas and themes related to the specific objectives of the study. Content themes were confirmed and validated through literature consultation, participant feedback, and professional teams.

Findings

Qualitative Findings

Content analysis of the interviews was conducted using the Staggers and Parks Nurse-Computer Interaction Framework (Staggers & Parks, 1993). The primary themes of this analysis highlight the particular relevance of *nurse characteristics,* especially time-management skills and job satisfaction, and *contextual characteristics* related to documenting at the point of care and orientation towards client care. Secondary themes concerning *characteristics of the device and assessment tools* are also discussed.

   Nurse characteristics. Skills in time management and planning for the clinical setting emerged as a primary theme with regard to willingness to adapt to CIS use. Nurses who anticipated the importance of clinical time-management for introducing the device to clients and for troubleshooting expressed more positive feelings about the device. Job satisfaction and positive attitude towards both the employer and the vocation of community nursing emerged as an important theme for willingness to adapt clinical practice to device implementation. Nurses who enjoyed educating clients and families, felt supported in their careers by co-workers and management, or connected with the vision of the agency also spent more time learning to use the device and seeking help in implementing it in the community.

Context characteristics. Integrating the use of the handheld device in a clinical setting was the primary theme. An orientation towards client care and a belief that patient care is positively affected by use of the device influenced nurses' willingness to adapt their practice and implement the BlackBerry. Furthermore, nurses who felt better able to measure and track client outcomes expressed more willingness to participate in training activities or seek feedback from colleagues in order to increase their ability to use the device at the point of care. Nurses who expressed difficulties connecting clinical outcome improvements to documentation at the point of care or through the use of standardized assessments were less willing to fully implement the CIS. These difficulties included lack of knowledge or language in how to introduce the device to clients or a sense of losing time with clients in order to complete the assessment. Notably, time 2 interviewees were more likely than time 1 interviewees to express the belief that the CIS was developed to improve client care.

The context of community nursing, specifically the independent nature of the work and the decentralized environment, also emerged as a theme related to CIS adaptation. Some nurses indicated that this unique environment made it difficult for them to attend training sessions or to be fully aware that training was necessary or available. Participants found it helpful to practise using the device. Learning was enhanced through sustained messaging at regularly scheduled team meetings.

Characteristics of the device. Characteristics of the device and the assessment tool were less likely to be discussed at time 2. Generally, interview participants commented that CIS provided useful features (e.g., appointment set-up) and was a comprehensive assessment tool, finding it particularly useful for long-term or palliative clients. Management support and the availability of problem-solving tools, especially during network outages, were noted as particularly helpful in encouraging troubleshooting and proper use of the device. Nurses also indicated that they looked forward to future enhancements to the handheld tool, such as the camera function for wound care. Critical reflection on expanded and enhanced use of the device in a clinical setting was not noted in time 1 interviews.

How evidence-based materials are best accessed in a clinical setting through the use of the handheld device was explored during time 2 interviews. Participants discussed a variety of barriers to accessing research during practice, including the limited capabilities of the device (e.g., poor access to Internet in some areas), lacking the time necessary to access the resources, and limited awareness of how or when to use research in daily practice.

Quantitative Findings

User satisfaction with the CIS system. Respondents reported using the CIS system to access clients' records (53.6% at time 1 and 57.1% at time 2), for telephone communication (98.2% and 96.1%), for e-mail (94.6% and 94.8%), for text messaging (66.1% and 70.1%), to access RNAO best practice guidelines (22.5% and 27.3%), to access the McMaster University Nursing Plus literature database (21.2% and 23.4%), and to access "other information resources" (28.3% and 49.4%).

Respondents were moderately satisfied with the overall features of the application (mean 5.02 at baseline and 5.03 at time 2). They were most satisfied with the terminology used throughout the application (6.43 and 6.72) and with the clarity of messages appearing on the screen (6.29 and 6.51). They reported the highlighting on the screen as helpful (5.74 and 6.19) and found the system easy to use (5.98 and 5.76) and easy to learn (6.14 and 6.35). Navigating the system was viewed as moderately easy (5.80 and 5.49) and correcting mistakes as relatively easy (5.77 and 5.19). There was a significant reduction in satisfaction with system speed between time 1 and time 2 ($p < 0.0090$) but a significant increase in satisfaction with having nurses' questions about the CIS addressed ($p < 0.0234$) and the relevancy of terminology to their work ($p < 0.0001$). No other significant differences were noted in usability evaluation.

Regression analysis indicated that the overall user reactions to the CIS were positively associated with ACT organizational structural and electronic resources and ACT social capital and were negatively associated with nurses' age at time 1 (see Table 1). Structural and electronic resources represent elements of an organization that facilitate access to and use of knowledge — for example, providing nurses with access to the Internet or mobile technology to facilitate their access to electronic information. Social capital comprises the informal exchanges between individuals working within an organization that can promote the transfer of knowledge (Estabrooks et al., 2011). Only one significant factor of ACT social capital was positively associated with overall user reactions at time 2 (Table 1).

Change in context for evidence-based practice and research utilization. Table 2 presents the scores for organizational context, evidence-based practice, and research utilization at times 1 and 2. The score for structural and electronic resources dramatically improved between time 1 (2.86) and time 2 (3.60). However, the score for feedback processes was significantly reduced, from 3.22 at time 1 to 2.94 at time 2. The scores for evidence-based practice and research utilization remained the same or did not show significant difference statistically over time.

Table 1 *Regression Analysis*

Response Variable	Variable	Estimate (95% CI)	p value
Overall user reaction	*Time 1*		
	Nurse age	−0.03 (−0.05, −0.01)	0.0227
	ACT structural and electronic resources	0.17 (0.05, 0.30)	0.0071
	ACT social capital	1.04 (0.46, 1.61)	0.0004
	Time 2		
	ACT social capital	1.24 (0.45, 1.98)	0.0009
Overall research use	*Time 1*		
	Nurse age	−0.03 (−0.05, −0.01)	0.0044
	Time 2		
	Nurse age	−0.03 (−0.06, −0.00)	0.0301
	ACT feedback	−0.57 (−0.98, −0.17)	0.0050
	ACT formal interaction	0.33 (0.047, 0.61)	0.0206

Table 2 *Organizational Context, Evidence–Based Practice, and Research Utilization*

Subscale	Time 1			Time 2				
	N^a	Mean (SD)	N	Mean (SD)	t value[b]	p value[c]
ACT leadership	117	3.83 (0.74)	80	3.69 (0.75)	1.34	0.1817
ACT culture	117	3.92 (0.56)	80	3.78 (0.62)	1.62	0.1071
ACT feedback	116	3.22 (0.84)	77	2.94 (0.88)	2.12	0.0349
ACT informal interactions	114	1.74 (1.38)	80	2.09 (1.54)	-1.63	0.1038
ACT formal interactions	114	1.56 (1.21)	80	1.78 (1.30)	-1.17	0.2428
ACT social capital	114	3.89 (0.57)	79	3.86 (0.51)	0.48	0.6326
ACT structural and electronic resource	114	2.86 (2.46)	78	3.60 (2.37)	-2.08	0.0388
ACT organizational slack: staff	114	3.21 (1.08)	79	3.17 (1.03)	0.28	0.7768
ACT organizational slack: space	114	3.61 (0.61)	79	3.59 (0.62)	0.27	0.7912
ACT organizational slack: time	114	3.26 (0.70)	78	3.09 (0.64)	1.76	0.0793
Instrumental research use	114	2.89 (1.50)	78	2.76 (1.51)	0.62	0.5328
Overall research use	113	2.61 (1.40)	77	2.61 (1.53)	0	0.9991
Attitude towards research	118	3.85 (0.57)	81	3.95 (0.52)	-1.22	0.2234
Belief willing to implement research	113	3.93 (0.56)	78	3.92 (0.58)	0.04	0.9698

Belief actually implement research	113	3.39 (0.85)	78	3.34 (1.03)	0.37	0.7119
Instrumental research use ("On your last day of work how often did you use research in this way?")	114	2.89 (1.50)	78	2.76 (1.51)	0.62	0.5328
Used research to change practice in past	113	3.68 (0.84)	79	3.76 (0.91)	-0.61	0.5401
Used research to change practice in last 6 months	113	3.73 (0.83)	79	3.65 (0.96)	0.62	0.5376
Intend to use research to change practice in the future	113	3.98 (0.79)	79	3.92 (0.87)	0.48	0.6310

[a] Total number of valid (i.e., non-missing) observations used in calculating means.
[b] T test performed to compare mean at times 1 and 2; a negative t value meant score increased from time 1 to time 2.
[c] P value less than 0.05 meant that the difference was statistically significant at 0.05 level.

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Nurses were asked to rate their research use and their attitude towards using research in practice on a scale of 1 (low) to 5 (high). The majority felt that over the preceding 6 months research had changed their practice (70.8%). Regression analysis showed that younger age was associated with overall research use at both time 1 and time 2. Organizational context of evaluation was negatively associated with overall research use but the influence of formal interaction was positive at time 2 (Table 1).

Discussion

In the discussion that follows, we will address the limitations of the study, examine the key findings, and describe the implications for future research.

Study Limitations and Strengths

The nurse data represented a sample of convenience comprising nurses who volunteered to take part in the study. A cross-sectional sample of nurses responded to the time 1 and time 2 surveys. It was not possible to link individual responses, which would have been useful for assessing change in attitude and research utilization over time. As a result, the use of multiple independent *t* tests increased the chances of a type 1 error. The strengths of the study include the use of multiple methods and multiple data sources, which minimizes threats such as common-method bias, and the use of established reliable and valid measurement instruments, which strengthens the internal validity of the findings.

Study Findings

The findings from this formative evaluation are consistent with those from a recent qualitative descriptive study of CIS implementation, which identified nurse-related, computer-related, and context-related facilitators of and barriers to CIS adaptation (Whittaker et al., 2009). System speed, manager support, timing of training, supportive staff, openness to change, positive outlook, and ease of use were facilitators identified in our study. Our findings suggest that it might be helpful to develop flexible nurse training programs that are designed to meet the needs of individual nurses based on their comfort with and knowledge about the technology.

Usability evaluation revealed that respondents were moderately satisfied with the overall features of the CIS. They were most satisfied with terminology throughout the system and there was a significant improvement over time in their belief that the terminology related well to the work they were doing. User feedback was employed to continuously improve the system throughout the formative phase of develop-

ment. Management support and the availability of problem-solving tools were noted as particularly helpful during the formative stages of implementation.

Successful implementation of information technology systems depends on a variety of factors, such as technical, individual, and organizational (Nowinski et al., 2007). Most of the research has demonstrated that user acceptance is a critical factor in successful CIS implementation (Ammenwerth, Mansmann, Iller, & Eichstadter, 2003). Barriers associated with the user and the organization/environment have been identified (Moody, Slocumb, Berg, & Jackson, 2004). The results of our formative evaluation are consistent with those reported in the literature. The strongest predictor of nurses' adoption of the new CIS was their attitude towards electronic documentation. Notably, access to structural and electronic resources and social capital were conducive to CIS adaptation. Social capital reflects the degree to which people in a group share information with others and participate in group activities, group exchange is focused on helping others do their job, and nurses believe that client conditions are taken seriously by those in authority (Estabrooks et al., 2009). It is possible that social capital in this study supported nurses' learning to use the CIS and also influenced their motivation to adopt the new technology in their practice. Access to structural and electronic resources represents elements within the organization that support nurses' access to knowledge resources, and these were found to be associated with nurses' willingness to use the BlackBerry to document through the CIS. Older nurses demonstrated greater resistance to the CIS than younger nurses. Although Whittaker et al. (2009) do not identify age as a nurse barrier to electronic documentation, they do identify lack of computer experience, which could reflect generational differences in exposure to computers throughout schooling and work life.

CIS implementation was expected to result in a change in the context for evidence-based practice and, in turn, nurses' research utilization. Our findings indicate a significant improvement over time in nurses' access to structural and electronic resources to support evidence-based practice. However, contrary to expectations, the cross-sectional sample at time 2 reported less access to feedback and evaluation than the sample at time 1. One possible explanation for this finding is that expectations may have been raised when the CIS was introduced and after 18 months these were not fully met. At 18 months the agency was in the early phases of implementing a team review of client outcomes and evidence-based practice. It will be important to re-assess nurses' perception of evaluation and feedback processes as the CIS becomes more ingrained in clinical documentation and as nurses gain more experience with team review of client outcomes.

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A number of contextual factors have been shown to inhibit evidence-based practice. These include unavailability of support staff, lack of equipment and facilities, and time and resource constraints (Koh, Manias, Hutchinson, Donath, & Johnston, 2008). Heavy workloads, being short-staffed, high patient-to-staff ratios, and high patient acuity have also been identified as barriers to the implementation of best practice guidelines (Koh et al., 2008; Milisen, Geeraerts, Dejaeger, & Scientific Working Party, 2009; Ploeg, Davies, Edwards, Gifford, & Elliot-Miller, 2007). Education and orientation of the guideline before implementation have been identified as facilitators (Egnatios, Dupree, & Williams, 2010). Ploeg et al. (2007) report that learning about the guideline through small-group interaction helped to integrate the guideline into practice and promoted positive attitudes. In the present study, the organization used the strategy of training through online resources, teleconferencing, and hands-on orientation, and respondent feedback underscored the importance of this training in the formative phase of implementation.

Our study focused on the formative phase of CIS implementation. Additional research, currently in progress, is exploring how implementation of the CIS intersects with improved clinical outcomes, client satisfaction, and organizational quality outcomes and will provide a more complete understanding of the impact of CIS implementation. Further research may be needed to determine what nurses' use of electronic devices means for one-on-one interaction between nurse and client.

Conclusion

The integration of electronic resources, assessment protocols, and best practice guidelines has the potential to support evidence-based practice in a community setting. We are on the brink of understanding the barriers, facilitators, and organizational factors that affect adaptation and integration of CIS in home care. This evaluation of implementation of an automated CIS has identified the importance of educational support, user-centred design, and responsiveness in informing CIS implementation and adaptation strategies in home care settings.

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Résumé

Améliorer les compétences et les connaissances des infirmières grâce à la technologie : un exemple de télésanté à l'étranger

Pammla Petrucka, Sandra Bassendowski, Hazel Roberts, Cessarina Hernandez

L'usage des technologies mobiles (les cellulaires) dans la prestation des soins de santé se répand presque partout. Il s'étend des applications simples (envoi de messages courts ou SMS) à des applications complexes en temps réel (télédiagnostic et télésurveillance). Parmi les possibilités offertes par la télésanté, la plus importante concerne la perspective de propulser au 21e siècle les services de santé dans les pays en développement. Les chercheuses ont introduit une plateforme et une infrastructure portable et conviviale dans des établissements de santé sélectionnés dans cinq lieux de la région des Caraïbes, pour ensuite analyser l'expérience des infirmières à l'égard de ce type d'intervention. L'étude révèle des effets positifs sur différents plans : qualité de la vie au travail et des soins; interventions fondées sur des données probantes; contributions des infirmières à l'intégration de la télésanté aux politiques en matière d'informatique de la santé. Les auteures décrivent le cheminement nécessaire pour favoriser la participation des infirmières travaillant dans des contextes caractérisés par une pénurie de ressources à la prestation de soins facilitée par les technologies mobiles. Elles présentent les leçons à retenir, les défis et les possibilités, ainsi que des recommandations susceptibles d'implanter ces outils essentiels au sein de milieux semblables.

Mots clés : technologies mobiles, télésanté, prestation des soins, pays en développement, Caraïbes

Enhancing Nurses' Care and Knowledge Through Access to Technology: An International m–Health Exemplar

Pammla Petrucka, Sandra Bassendowski, Hazel Roberts, Cessarina Hernandez

The use of mobile technologies (i.e., cell phones) in health care is becoming increasingly ubiquitous. From simple (i.e., short message service, or SMS) to complex and real-time applications (i.e., diagnostic remote monitoring), the greatest opportunities lie within the potential of mobile health (m-health) to leapfrog health care in developing countries into the 21st century. This study explored m–health at select health-care sites in 5 Caribbean settings. By intro-ducing and evaluating a user-friendly handheld platform and infrastructure, the study examined nurses' experiences with an m-health intervention, revealing positive impacts on quality of work life and care, evidence-informed approaches, and nurses' contributions to m-health inclusiveness in health informatics policies. The authors describe the path, in resource-challenged environments, to fostering nurses' participation in m-enabled health-care environments. They share lessons learned, challenges and opportunities encountered, and recommendations for bringing these vital tools to similar contexts.

Keywords: mobile technologies, m-health, health informatics, information and communication technology (ICT), Caribbean

The Mobiles for Development project is funded by the International Development Research Centre (IDRC) to enhance nurses' uptake of and exposure to mobile health (m-health) and health information via hand-held devices. It has established a user-friendly information and commu-nication technology (ICT) infrastructure with two objectives: to augment quality of work life and care in select health-care sites in five Caribbean settings, and to establish an evidence-informed approach to national/ regional health informatics inclusive of personal digital assistants (PDAs) or similar handheld devices for health-care providers.

Study Rationale

The project was launched at a time when ICTs such as m-health were emerging and being rigorously debated — often in the context of set-tings in the developed world. The team saw an imperative to introduce,

integrate, and embed ICTs within health-care systems in developing countries. Hence five Caribbean settings were selected: Dominica, the Dominican Republic, St. Kitts and Nevis (two sites), and St. Lucia. Our team comprised academic researchers from the University of Saskatchewan and our Caribbean collaborators.

Based on local priorities, our project considered *places, people,* and *potentials* in the rationale for the project. *Place*s included the decision to conduct the work within the public health system in each of the partic-ipating Caribbean settings. This decision was based on both the perceived need to engage policy/decision-makers in the ICTs for health early on and the opportunity to strengthen the institutional health sector. *People* included a focus on the target group of health providers as direct partic-ipants and their patients, their co-workers, and the health-system team as indirect participants. In the discussions with governments and health-care bodies (i.e., professional regulating bodies), it was decided that nurses would be the direct participants, as nurses not only were the largest provider group but were a subset of health providers often disadvantaged or overlooked in the health-care systems in these Caribbean settings. *Potentials* reflected the key areas for integration of the ICTs to enhance nursing's presence and its capacities for quality care.

Literature Review

The growth of mobile technologies in health and health care over the past decade yielded nearly six billion mobile subscriptions globally by the end of 2011 (International Telecommunication Union, 2011), up nearly 20% since 2009. Despite this near ubiquity and immense potential in terms of health applications, Burke and Weill (2005) remind us that "technological developments make more effective health care a possibil-ity; however, they do not make it a reality" (p. 205). Yet there is limited evidence of the impact of such technologies on health (Donner, 2004; Kaplan, 2006; Mechael, 2006), health providers (*The Economist,* 2005; Petrucka, Bassendowski, James, Roberts, & Anonson, 2010), health systems (Curioso, 2006; Ducat & Fontelo, 2008), and health information (Leon, Fontelo, Green, Ackerman, & Lui, 2007).

Many m-health studies have yielded inconclusive or tentative results (Ducat & Fontelo, 2008; SATELLIFE, 2005) in terms of the m-health agenda. Articulating the m-health agenda for development and research is hampered by the complexity and diversity of m-health devices, inter-disciplinary interdependence, and complexity of deployment. Some authors have attempted to categorize existing and emerging applications. According to Tessier (2010), such applications fall into 12 m-health "application clusters": patient communication, access to resources, point-

of-care documentation, disease management, body-area networks, education programs, pharma/clinical trials, professional communication, public health, emergency medicine, financial applications, and administrative applications. Another challenge is the rapid evolution of m-health technologies. Silberglitt, Anton, Howell, and Wong (2006) describe a list of emerging technologies, expected to be adopted by 2020, among which the front-runners are health-services applications (i.e., improved diagnostic and surgical methods), access to information (i.e., wireless), and environmental sustainability (i.e., water purification). Additionally, there are necessary philosophical shifts, such as Fuscaldo's (2004) vision for a system based on m-health, where the "patient becomes the point of care, not the doctor or the hospital," especially through self- and remote monitoring applications (Lacal, 2003).

So, reflecting on the challenge of Burke and Weill (2005) noted above, the research that will be described herein embraces the vision of health-care providers and health systems taking on technological diffusion and transforming technological enablement into m-health realities.

Study Design

The project initially focused on the opportunity to introduce ICTs in a manner that would embed and integrate the technologies into clinical practice and clinical knowledge transfer and address local priorities. It considered the social and the technological equally at all stages. As the project developed, it became apparent that the participants were seeking quality care and evidence-informed practice; the project was based on the contextual reality of a lack of access to ICTs (specifically, m-health devices) within the health-care systems in the five participating settings. This deficit was seen to potentially impact negatively on clinical practice, clinical knowledge, and evidence-informed patient care in these settings. Further, enhancement and appropriation of ICTs was envisaged as enabling real-time or near-time access to relevant health-care information (ICT-mediated) within the settings, thereby impacting on the quality of care and the capacities of care providers.

Goals and Objectives

The overall research focus was to determine the role(s) and impact(s) of innovative ICTs such as PDAs or wireless system (PDA2W) in enhancing clinical practice and patient care through access to relevant health-care information (ICT-mediated) at select Caribbean public hospitals. As the project evolved, there was exponential development and uptake of m-health opportunities and innovations globally. So, although the original focus remained foundational and valid, it became incumbent on the

research team to increasingly shift the emphasis towards the emerging m-health environment and context. This research challenge informed the development of three objectives:

1. Demonstrate and analyze the use of the PDA2W system and integrated applications in enhancing patient care through access to evidence-informed/evidence-based resources in concert with regional protocols and standards.
2. Research and build capacity of the end-users (nurses, student nurses) with the PDA2W network to facilitate its appropriation and contributions to quality of work life and care through applications and technology, including podcasting, evidence-rich portals (i.e., Nurse ONE), and ongoing training/monitoring.
3. Assemble promising practices at the local and regional policy/decision-maker levels respecting findings from objectives 1 and 2 that demonstrate and facilitate integration of m-health initiatives across the spectrum, from point of care to health information management systems (HIMS), in the Caribbean context.

Method

The research design was community-based participatory action research intended to monitor, facilitate, and evaluate the introduction of ICTs in select health-care settings. In accordance with Stoecker's (2009) initiator model, the research team focused on mobilizing the target population/community around the potential change/challenge of uptake and embedding of technologies for quality care and knowledge exchange. The design included a dynamic, cyclical process (see Figure 1), which intertwined *training, technology introduction/augmentation,* and *monitoring and evaluation* for each of the critical activities.

Sample

The sample comprised 254 nurses and 23 nursing students. Over 95% of the participants were female. The combination of practising and student nurses allowed for consideration of intergenerational practices, knowledge, and ICT competencies. The potential participants worked/studied at one of the selected public institutions. Information sessions were held at each site, during which the project was described, questions were addressed, and all practising and student nurses were invited to participate. From among those who agreed to participate, random selection was conducted, followed by random assignment to either the study group or the comparison group.

Research ethics approval was secured from the Behavioural Research Ethics Board of the University of Saskatchewan.

Figure 1 *Iterative Research Design*
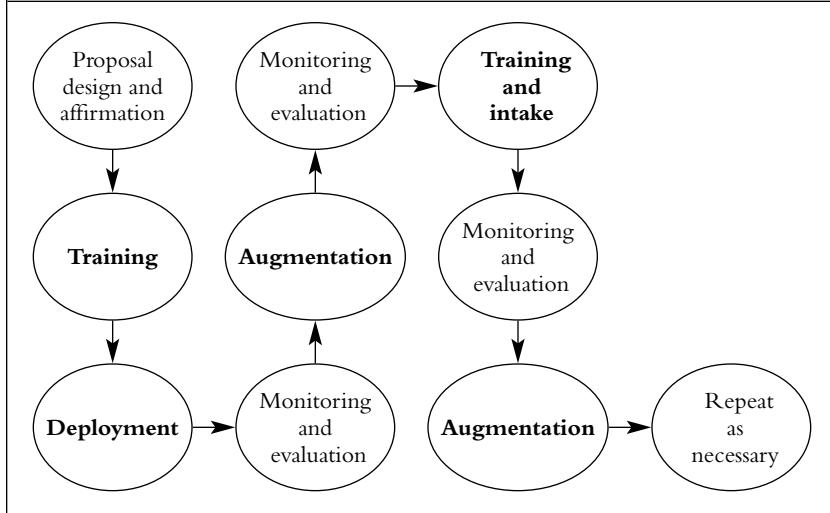
Data Collection

The research tools were a mixture of quantitative and qualitative approaches, purposefully chosen to capture empirical and theoretical aspects over a 4-year period. The strategy, rationale, and tool(s) for all components of data collection are summarized in Table 1.

Data Analysis and Key Findings

Data analysis was undertaken for each tool in accordance with the respective data sets; hence, text and numerical data were separately considered, with triangulation of data sources as appropriate. The analysis approach and key findings for each of the data-collection strategies are discussed briefly below.

Environmental scan. Initially, the research team drew up brief overviews for each of the five settings based on the templates and document reviews. Due to limited or still-emerging information, these reviews were incomplete, unavailable, or inconsistent. Additionally, the intended cross-setting comparisons became complex and non–contributory due to the often generic and early-stage content of the documents provided. However, key findings from the environmental scan were the common elements of a need for m-health and the imperative for a provider-driven m-health agenda.

QoWLC. For this research, our interest was limited to eight Likert-scale questions related to QoWLC and technologies. The participants'

Table 1 *Summary of Data–Collection Approaches*		
Collection Strategy	**Rationale**	**Tools**
Environmental scan	To determine state of ICTs in health within the participating countries and across the Caribbean	STEEP (Social/demographic, Technological, Economic, Environmental, Political) technique to gather baseline and ongoing situational data. Document reviews
Quality of work life and care (QoWLC)	To measure impacts of introducing the PDA2W system on individual nurses	QoWLC tool examining nurses' demographics, situational analysis, and role perceptions, administered pre- and post-introduction of PDA2W
Work sampling studies	To assess impacts of deployment and stabilization of the PDA2W system on efficiencies and safety in care through access to information	Select work activities (patient education, time to obtain medication/treatment information) monitored and compared across 4 to 5 data-collection points per setting, in both study and comparison groups, across time (i.e., participant as own reference)
e-HEALS	To ascertain level of confidence and use of Internet as a health resource in 25% of English-speaking participants	e-HEALS pre-/post-test
Key informant/focus groups	To determine needs, challenges, and potential innovations across the life of the project	Directed and small-group interviews throughout study (i.e., environmental scan, annual meetings, podcast development)
Brief note	To provide continuous, near real-time feedback on the project generally and technologies specifically	Participants provided feedback on a quarterly basis through e-mails to the PI

responses reflected a favourable change in their work life and care environments and in their perspectives on technology, quality of work life, and impacts of technology. This change was measured using select questions (pre- and post-) from the QoWLC survey (see Table 2). The key finding for the QoWLC was that evidence and a workplace culture of evidence-based practice were significantly influenced by the availability and application of ICTs.

Work sampling studies. Our original intention was to use work sampling results as a surrogate indicator for time/resource economies related to the introduction of ICTs. To gauge the efficiencies associated with the PDA environment, the work sampling studies were conducted on a regular basis during the first 18 months of the project. This frequency was found to be sufficient to show the peaks and eventual plateauing of the benefits of reduced time to access evidence and clinical information. The analysis of the work sampling data was essentially reflected in descriptive statistics. The key finding was, in addition to savings of time, a novice-to-expert pattern, depending on participant capacities related to prior keyboard devices, Internet exposure, and health information literacy.

Table 2 *QoWLC Survey: Pre- and Post-test Results for Impact of Technology*[a]		
Quality of Nursing Work Life and Care	**Pre-introduction of ICT**	**Post-introduction of ICT**
Collaborating With Co-workers Openness in communication	3.03	3.88
Level of interaction with other health professionals	2.89	3.97
Support for Nurses' Work Availability of ICT	1.77	3.61
Availability of needed equipment	2.49	3.64
Work Life and Workplace Culture Currency related to new developments	3.24	3.79
Evidence-Based Practice Availability of best practice evidence	1.91	3.36
Application of evidence-based findings	1.03	3.77
Leadership Selection of technologies	1.08	2.59
[a] Scale of 1 to 5 (1 = strongly disagree, 5 = strongly agree)		

Figure 2 *Technology-Specific Thematic Word Cloud*
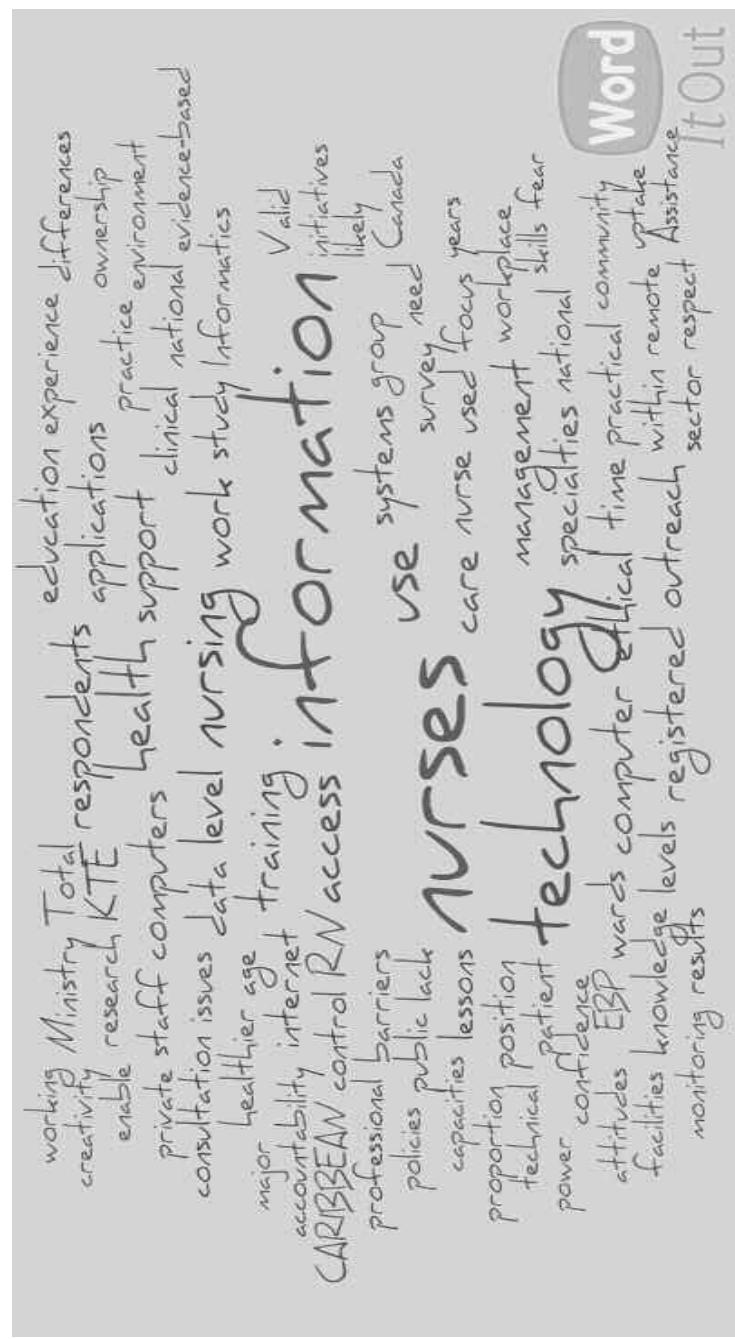
e-HEALS. The e-HEALS tool considered the likelihood of participants and patients using the Internet to access health information. Although the majority of respondents were aware of online resources and had used them in health decision-making, only one third (approximately) rated such resources as important or very important. The key finding for this tool was relatively low reliance on the Internet for health information, for both personal and professional purposes.
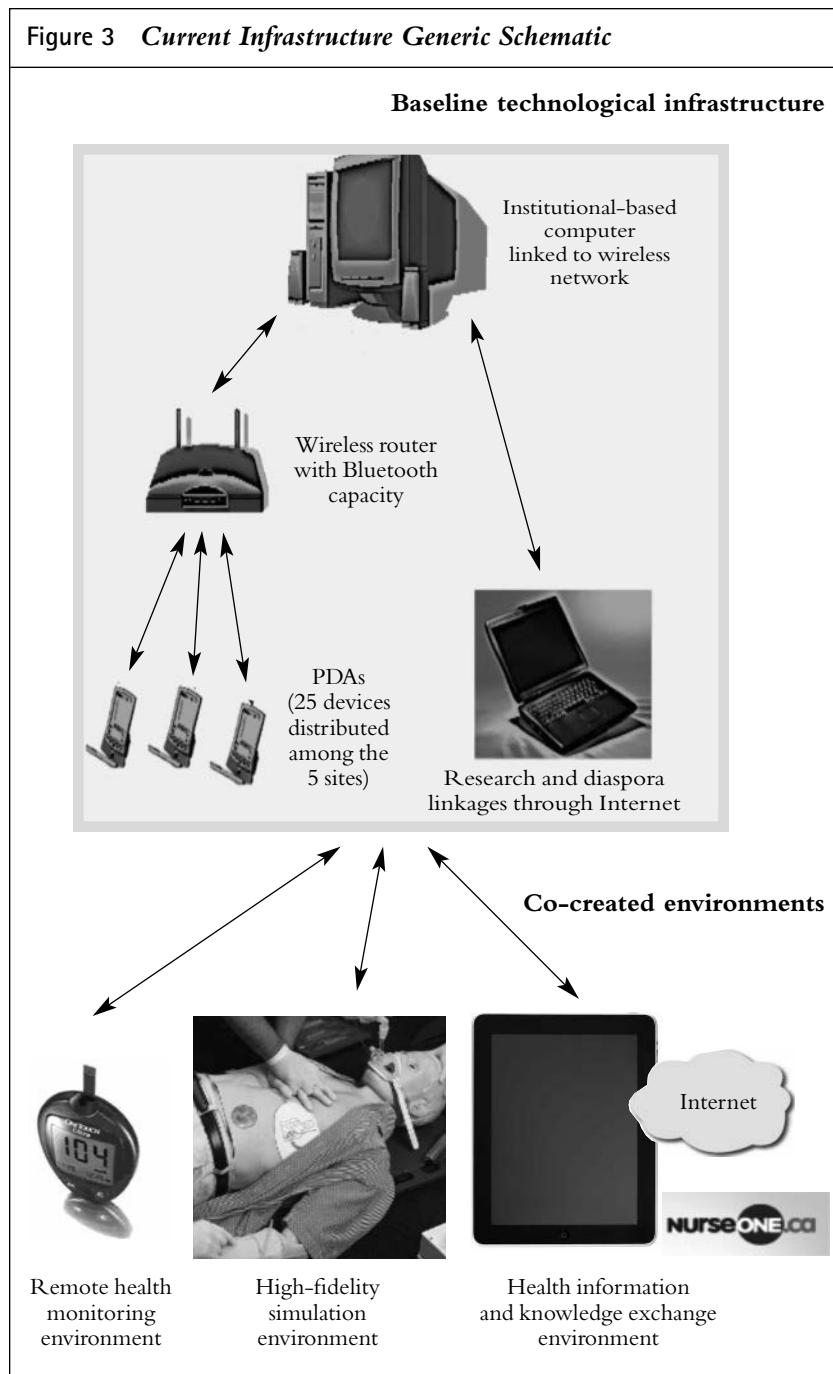
Key informant/focus groups and brief notes. The data were analyzed using thematic analysis and word-frequency analysis at both the midpoint and the conclusion of the study. This method was a familiar one for the participating agencies and partners, lending a richness and depth of insights and insider perspectives. At the midpoint, major themes categorized were *technology-specific* (i.e., value added, practice-changing); *content-specific* (evidence-based, competencies); and *general* (personal growth, appreciation). This list expanded in the final iteration to include *policy-specific* (advocacy, enabling policies). The *technology-specific* category became less of a focus as the project progressed, perhaps indicating a growing level of comfort with the technology, complacence, or normalization. The *content-specific* category was the most dynamic across the two time periods, showing evidence of increased momentum towards evidence-based protocols, care, and environments (nearly tripling in frequency). The added *policy-specific* category emerged in the latter portion of the project, appropriately, as participants likely had little insight or interest in the early stages (which were taken up with devices and learning curves). The themes were presented using a series of word clouds (see Figure 2). The key findings for this tool related to the interdependence of the categories to achieve a well-designed and sustainable way forward.

m-Health intervention findings. The technical aspect of the project was a critical contribution reflecting both core hardware and core software, with ongoing augmentation in response to the participants' needs and contextual changes. The outputs and impacts of these technical innovations were measured using a number of the tools, especially work sampling studies and QoWLC, as shown in Table 1.

PDA2W Core Hardware

The building of the PDA2W networks was a systematic and iterative process, highly individualized for each site. Initial determination of the PDA2W baseline requirements included potential compatibilities and capacities of wireless routers and peripherals within targeted units as well as identified technical constraints. PDA2W infrastructure became the backbone upon which the project supported a range of innovative and emergent tools and devices, hardware, and software (see Figure 3).

Figure 3   *Current Infrastructure Generic Schematic*

Baseline technological infrastructure

Institutional–based computer linked to wireless network

Wireless router with Bluetooth capacity

PDAs (25 devices distributed among the 5 sites)

Research and diaspora linkages through Internet

Co-created environments

Internet

NurseONE.ca

Remote health monitoring environment

High-fidelity simulation environment

Health information and knowledge exchange environment

This intervention demonstrated, from a technical standpoint, the functionality and stability of wireless capacity within select hospital environments.

Windows Mobile-based PDAs (i.e., Hewlett Packard IPAQ) were sourced, preconfigured, and deployed. Both English and Spanish versions were acquired to better meet the language needs of the participants. Each agency was provided with access to an Internet-capable desktop computer containing the same software as that available on the PDAs. This was essential and ethically imperative to ensure that all nurses had access to care guidelines, health information, and professional development resources.

Near the midpoint of the project it became obvious that an enabling environment for such technologies in health care was emerging. We likened our context to the movement from "infancy" to an energetic/active "youth" phase in which we could fully participate.

PDA2W Core Software

Basic programs such as Adobe Reader, Archimedes, and Diagnosaurus were installed in advance. We referred extensively to these free resources at http://library.uchc.ecu/pda for ongoing augmentation to the baseline software package, as well as to focus group feedback, research findings, and agency/unit requirements (e.g., obstetrics/midwifery). As the software palette was selected, a core package, including RNNotes, Manual of Nursing Practice and Procedures, Nursing Drug Handbook, Taber's Medical Dictionary, and Manual of Nursing Diagnosis, plus the 5 Minute Consult program, were included. In the latter stages of the project, participants were adding programs independently, mostly notably from sites such as www.studentdoc.com/free-pda-medical-software.html and www.epocrates.com.

PDA2W Augmentation

During the project, two hardware augmentations and one software were introduced. An overview will be provided, with publication of research findings anticipated.

Remote health monitoring (RHM). The project included a clinical RHM application related to blood pressure and blood glucose monitoring in partnership with SaskTel and Alcatel Lucent. These sensor devices were selected in consultation with the participants and the project team to focus on chronic conditions (diabetes, hypertension), as these are areas of increasing health concern in the Caribbean region. The purpose was to demonstrate the value of layering an RHM service onto the existing ICT infrastructure using existing PDAs as an aggregation device. This component was a technical feasibility element rather than a clinical trial, so information was linked not to specific patients but, rather, to particular

patient beds. As the project unfolded, opportunities arose to use RHM community-based applications. We used the units for free public clinics in malls and barber shops — essentially, places where people meet and have some "uncommitted" time. Although the sensor devices were, at times, limited to being data vaults when there was no wireless capacity, data were captured and later transmitted.

High-fidelity simulation (HFS). With the establishment of stable wireless systems within health-care environments and beyond, the implications and potential for innovation are seemingly endless. Given the stability of the wireless systems in St. Lucia, the research team, in consultation with the IDRC, moved to the introduction of a wireless-enabled HFS mannequin (Gaumard HAL 3101), to be used primarily for clinical training of the participating nurses. Our intention was threefold: (1) to establish a training model using HFS that will potentially create a "centre of excellence" model for this partner site; (2) to undertake the formative design of a study to be led by the partner site (i.e., St. Lucia) with the assistance of the lead PI; and (3) to enhance and extend the utility of the backbone wireless capacity and participant competencies potentiating sustainability. Following the training, the St. Lucia team continued to work with the Regina Qu'Appelle Health Region simulation site to plan scenarios, review protocols, and advance the potential of simulation training at their respective sites.

NurseONE. The focus on professional development was considered important given the identified gaps in available information and resources for quality evidence-informed care. Our interest was in using the PDA2W infrastructure and tools to address these gaps. The first task was to address the participants' varying levels of health informatics skill and competency. The second was to stimulate interest in professional development using technology. Many participants found that they lacked the time and opportunities to explore, experience, and learn this type of non-traditional approach. In order to address this concern, we introduced NurseONE/INF-Fusion, a portal of the Canadian Nurses Association (CNA) (www.nurseone.ca). NurseONE is a personalized, interactive Web-based resource providing nurses across Canada with a gateway through which to access resources for the delivery of effective evidence-based care and to enhance their clinical and professional expertise. The portal provides access to more than 1,000 full-text journals, 600 e-books, and a range of resources and databases for practising nurses. The CNA took steps to increase access to contextually and linguistically relevant resources for our participants.

Lessons Learned, Challenges, and Opportunities

The five key lessons learned through this project have informed future directions and current potential.

Lesson 1: Build m-Health Awareness and Availability First

In this study, participants (both the practitioners and the participating sites) had varying levels of experience with ICTs; however, they were all new to m-health. The research confirmed the growing trend towards ICTs generally and m-health specifically, within the health-care sector and within nursing. The project contributed to the participants' understanding, uptake, and development of competencies related to ICTs in a manner aligning closely with the first stage of Rogers' adoption process (Borrego, Froyd, & Simin Hall, 2010; Rogers, 2003). However, a significant effort at the front end was necessary to build an understanding of m-health using a practitioner lens as well as from a development perspective. The project was successful in increasing the participants' individual awareness and, later, collective interest in and advocacy for m-health (devices, processes, and policies) within their respective health sectors, paralleling findings of the European Technology Platform (2012).

Further, the participants clearly indicated that Internet access made health information available to both providers and patients; hence the technology and, more importantly, its appropriate use were critical to access to information.

Lesson 2: Ground Within the Local Context

Many of our efforts were focused on awareness, readiness, access, and process, which partly aligns with the suggestions of Heeks and Molla (2009). In this project, the challenge was to deal with the varying states of the participating sites in terms of their understanding of and/or belief in the potential of ICTs for their health-care delivery models. This included ensuring buy-in across sectors and on the part of relevant government departments, a finding shared by Woodward, Feldman, and Snider (1997). Through the project, each of these elements was considered and addressed, yielding a series of stable and functional augmented PDA2W infrastructures based on local priorities and building local capacities. These efforts were necessary, foundational, and informative for the way forward, and they mirror the experiences of Barab and Squire (2004) and the European Technology Platform (http://www.cordis.europa.eu/technologyplatforms/ict_en.html).

Lesson 3: Embed Evidence/Content to Catalyze Innovation Uptake

The true impact of this project and m–health projects in general resides in the uptake/utilization of the technology for evidence-informed practice (Hewapathirana, 2010; Tessier, 2010). Ultimately, the project addressed development through uptake/utilization to reduce inequities in distribution of ICTs (as a desired resource) and increase access to knowledge and evidence through this infrastructure. The participants were highly engaged in searching for health information, clinical evidence, and practice guidelines.

Lesson 4: Coordinate for Achievement at Different Levels

The multisite nature of the research made it imperative that we respond individually to the sites while concomitantly ensuring that key milestones were reached across all sites before moving forward. This allowed for economy of scale and possible reduction of duplication.

Lesson 5: Attend to Knowns and Be Attuned to Unknowns

The research team realized that Mick and Fournier's (1998) eight paradoxes were variably evident within this introduction to innovation. Most significantly, we were aware of examples of how the technology affected movement between control/chaos, competence/incompetence, and engagement/disengagement. As the project was being launched, we saw that there was a significant amount of work to be done upfront, revealing the need to allow more time for the first stage of the intervention. A prolonged time allowance for most activities remained a requisite throughout the project, in order to permit us to address the control/chaos and competence/incompetence paradoxes. Ensuring full engagement in the project, particularly with respect to research skills, was critical in terms of both competence/incompetence and engagement/disengagement. We found that comfort ended with the planning and collection phases but only limited engagement was possible for analysis and dissemination efforts from our partner researchers. A formal training module could facilitate and build capacities across multiple projects and become a mandatory training element prior to engagement, but this was beyond the scope of the project. As we continued to address each of the paradoxes, the work of Emanuel, Wendler, Killen, and Grady (2004), describing collaborative partnerships, was increasingly relevant in informing the imperative of balancing project needs with mutual respect and mutual benefits.

In addition to the lessons learned, a number of challenges and opportunities were identified. Methodologically, the pre- and post-QoWLC survey, as well as the brief notes, provided evidence of growth, develop-

ment, and success. The lack of a research ethics review process at the participating institutions, combined with a low overall level of understanding of research ethics, remains an area for future development. Data analysis was problematic due to lack of experience and confidence among the participating team members. This step defaulted almost exclusively to the PIs, which suggests a need for training at future partner sites. The international research team worked collaboratively, recognizing individual and collective strengths and capacity-development needs. The project built a number of relationships both locally and globally. Of note, several participants have undertaken further education or have expressed an interest in doing so. Significantly, South-to-North learning has been critical (Mechael & Curioso, 2010), with two projects modelled on the PDA2W and Canadian nurses following in the footsteps of their Caribbean counterparts — a validating experience for the Caribbean partners.

The Way Forward

This intervention was a Mobiles for Development project to enhance uptake and exposure to m-health technologies and health information via devices for nurses at five Caribbean sites. Its objective, which was achieved, was to improve quality of work life and care for nurses through capacity-building. The project built and co-created a user-friendly ICT infrastructure comprising an array of wireless-capable devices, ranging from handhelds to life-size high-fidelity simulation mannequins. The intervention holds promise as an appropriate, simple, and useful transition to ICTs and mobile technologies for the health sector at other resource-compromised sites.

The project yielded three recommendations for uptake and utilization of m-health tools for quality, care, and knowledge in resource-constrained environments. The first is to advance evidence-based health care through ICTs and m-health tools such as those implemented. Aligning the technology with this important step towards knowledge uptake and transfer represents an opportunity to increase utility and sustainability. The second recommendation is to encourage, enable, and empower participants and stakeholders to advocate for ICT-enabling health-care policies. Participants quickly become experts and the best voices for necessary changes. They understand, embrace, and envisage an m-health future as the preferred one. The third recommendation is to firmly root the introduction of m-health technologies in capacity-building efforts. This demonstrates that m-health is not about technologies for their own sake, but about the ability of practitioners, such as the participants in this project, to use technologies to improve quality, care, and knowledge in their respective contexts.

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Acknowledgements

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Happenings

Nursing Informatics

Elizabeth M. Borycki, Noreen Cavan Frisch

The science of nursing informatics is advancing globally and making contributions to the body of knowledge on nursing and health informatics worldwide.

There have been a number of important international and national events in this field in the past year. The Nursing Informatics 2012 conference was held in Montreal, NANDA-International celebrated its 40th anniversary in Houston, and the Canadian Association of Schools of Nursing (CASN) released its entry-to-practice competencies for nursing informatics. The coming year will also see a number of key events, including the Canadian Nursing Informatics Association (CNIA) conference in Montreal, MedInfo (the conference of the International Medical Informatics Association [IMIA]) in Copenhagen, and release of the update to the International Classification for Nursing Practice (ICNP).

Events and Milestones in 2012

Nursing Informatics 2012

The IMIA Nursing Informatics Working Group held a conference in Montreal from June 23 to 27 under the theme "Advancing Global Health Through Informatics." Representatives from 38 countries contributed to the conference program and attended presentations, panels, and workshops. This event allowed for knowledge translation among nursing informatics professionals working in different health-care organizations (e.g., clinics, hospitals, and regional health authorities). World leaders in the field provided insights into current research and future directions in nursing informatics from an international perspective. This was an opportunity for Canadian nursing informatics professionals to meet others from around the globe and forge connections with other nurses working in this area. http://www.ni2012.org/files/NI2012-FINAL-PROGRAM.pdf

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NANDA-*International: 40th Anniversary*

NANDA-International (renamed in 2002 from the North American Nursing Diagnosis Association to reflect the organization's international mandate) held its biennial conference and 40th anniversary celebration in Houston from May 23 to 26. The conference theme was "Defining the Knowledge of Nursing" and delegates from around the world presented research on nursing outcomes, patient safety, education, and technologies. Over 150 papers provided up-to-date research on the effectiveness and impact of this standardized language system for nursing, augmented by 120 research posters. The event also marked the 20th anniversary of the Nursing Interventions Classification (NIC) and the 15th anniversary of the Nursing Outcomes Classification (NOC), both used by many in conjunction with the NANDA-I terms. The international flavour of the conference was reflected in simultaneous translation of many sessions into Spanish.

CASN: Informatics Competencies

Also in 2012, CASN and Canada Health Infoway (CHI) published the first set of informatics competencies in Canada articulating the competencies required for entry-to-practice registered nurses. Funded by CHI, the project promotes awareness within Canadian nursing education of the need for graduates to have specific knowledge in this area. To develop the competencies, the Competency Development Working Group, with national representation, engaged in a multistep process to arrive at consensus. More information is available at http://www.casn.ca/en/Whats_new_at_CASN_108/items/123.html.

The CASN working group continues to develop teaching tools and supports for nursing educators to incorporate informatics competencies into their curricula.

The Year Ahead in a Nutshell

CNIA Conference

The Canadian Nursing Informatics Association conference will be held in collaboration with the Canadian Health Information Management Association (CHIMA) and the International Federation of Health Information Management Associations (IFHIMA) at Montreal's Palais des Congrès from May 12 to 15, 2013. Speakers from around the world will address a range of topics in nursing and health informatics. CNIA will be holding a pre-conference session on "The Science and Practice of Nursing Informatics" on May 12. Nursing informatics professionals are invited to attend both this session and the conference itself (http://www.cnia.ca).

MedInfo 2013

The IMIA will hold its biannual conference in Copenhagen from August 20 to 23. The event is organized around several tracks, including translational bioinformatics, clinical informatics, clinical research informatics, consumer informatics, and public health informatics. In addition to the presentation of papers, the conference will include poster sessions, panels, workshops, and tutorial presentations and is expected to draw professionals from around the world (http://www.medinfo2013.dk).

ICNP

A May 2013 release is planned for the update to International Classification for Nursing Practice. This initiative reflects an emphasis on developing terminology subsets to meet nurses' information needs in hospitals, in ambulatory-care settings, and in the community. These subsets, published as catalogues available both in print and online, consist of clinically relevant, coordinated statements for nursing diagnoses, nursing interventions, and nursing-sensitive outcomes. The statements provide nursing content for electronic health records. More information on ICNP catalogues can be found at http://www.icn.ch/pillarsprograms/ehealth/.

The body of knowledge that makes up the science of nursing informatics is growing rapidly. Around the world, nursing informatics professionals are spearheading the advancement of knowledge and best practices involving health information technology design, development, implementation, and evaluation.

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Book Review

Informatics and Nursing:
Opportunities and Challenges, 4th edition
By Jeanne Sewell and Linda Thede
Philadelphia: Lippincott Williams & Wilkins,
Wolters Kluwer Health, 2013, 477 pp.
ISBN: 978–1–60913–695–6

Reviewed by June Kaminski

"What is informatics? Isn't it just about computers? Taking care of patients is nursing's primary concern, not thinking about computers!" These opening lines of chapter 1 set the stage for a practical and comprehensive journey through the ever-evolving field of informatics in health care. Right from the start, the context of this book is firmly situated in the real world of nursing practice. This is the kind of book that should be required reading on every nursing unit, in preparation for imminent system implementation and to cultivate a culture of inquiry and exploration into the possibilities introduced by informatics.

As expected, the book begins with a definition and overview of informatics, asserting that it is more to do with information management than with computers. Since nursing practice revolves around information management, in every task that nurses undertake and in every encounter they experience, informatics is a natural fit for every nurse, in every practice setting. The authors present informatics through a three-pronged lens: information management, computer competency, and information literacy. Using these perspectives, they make a convincing argument for how naturally information technology fits into the day-to-day activities of professional nursing. A comprehensive history of the evolution of computers and informatics theory and practice is also framed within these perspectives, followed by an overview of common software, including operating systems and group and networking programs. Subsequent chapters focus on computer components and software frequently used in professional and personal lives, including word processing and network programs.

The book is organized into 25 chapters presented within seven units. Unit III focuses on information literacy, walking nurses through the basics of accessing information through electronic means: specifically, the Internet, digital libraries, and mobile technology such as smartphones,

PDAs (personal digital assistants), and tablets. Units IV through VI delve into the way that health care is evolving, with a strong focus on information technology use in a variety of settings and processes. Topics range from the empowered consumer who accesses health information through information technology to the use of electronic health records and computerized medication administration systems. The final unit, VII, covers the use of informatics in education, administration, and research, concluding with a chapter on the legal and ethical issues of using technology in health care. Each chapter conveys the message that informatics supports nursing, wherever it is applied.

The print version of the book is bound in a compact way, with standard page size and flexible soft cover, making it easy to carry and to read. The online version, available from the publisher through thePoint, is presented in an aesthetically pleasing way, closely replicating the graphically attractive layout of the print version. This format makes for a significantly enhanced reading experience compared to plain-text-on-white-background e-texts. Either version will serve as a practical resource for both practising nurses and nursing students. Online student and instructor resources offer a variety of supplemental information, including relevant articles in pdf format, PowerPoint presentations, test-generator questions, objectives, illustrations, and teaching strategies.

To conclude, *Informatics and Nursing: Opportunities and Challenges* is a highly recommended book. The authors, both nursing informatics experts, offer a seasoned and encouraging approach to applying informatics to professional nursing as well as to nurses' personal lives. They provide a realistic view of the benefits and pitfalls associated with using computer equipment and electronic information in health-care settings. They do so by threading the essence of information management and literacy through each of the chapters. The result is a very usable and valuable book for both nursing practice and education.

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Résumé

La découverte de connaissances fondée sur la pratique à des fins de recherche sur l'efficacité comparative : un cadre organisationnel

Robert J. Lucero, Suzanne Bakken

Les systèmes d'information électroniques sur la santé peuvent accroître la capacité des organismes de soins de santé à étudier les effets des interventions cliniques. Le présent article propose un cadre organisationnel qui intègre les paradigmes de la recherche en informatique et de la recherche sur les résultats afin de faciliter la création de connaissances à l'aide de bases de données cliniques. Afin d'illustrer le cadre proposé, les auteurs l'appliquent à l'exemple des plaies de pression. Ce cadre de création de connaissances à l'aide de l'informatique aux fins de la recherche comparative sur l'efficacité des traitements (CCI–RCET) a été conçu dans le but de servir d'outil heuristique pour la conceptualisation des modèles d'étude et de surmonter les contraintes méthodologiques que peut éventuellement imposer toute perspective de recherche unique. Les percées de la recherche en informatique appliquée peuvent jouer un rôle complémentaire dans le développement du champ de la recherche sur les résultats, y compris de la recherche comparative sur l'efficacité des traitements. Le cadre de CCI–RCET peut être utilisé afin de favoriser la production de connaissances à partir des données cliniques électroniques qui sont recueillies de façon systématique.

Mots clés : bases de données cliniques, recherche comparative sur l'efficacité des traitements, modèles d'étude, production de connaissances, informatique, recherche

Practice–Based Knowledge Discovery for Comparative Effectiveness Research: An Organizing Framework

Robert J. Lucero, Suzanne Bakken

Electronic health information systems can increase the ability of health–care organizations to investigate the effects of clinical interventions. The authors present an organizing framework that integrates outcomes and informatics research paradigms to guide knowledge discovery in electronic clinical databases. They illustrate its application using the example of hospital acquired pressure ulcers (HAPU). The Knowledge Discovery through Informatics for Comparative Effectiveness Research (KDI-CER) framework was conceived as a heuristic to conceptualize study designs and address potential methodological limitations imposed by using a single research perspective. Advances in informatics research can play a complementary role in advancing the field of outcomes research including CER. The KDI-CER framework can be used to facilitate knowledge discovery from routinely collected electronic clinical data.

Keywords: comparative effectiveness, knowledge generation, informatics, health services, research, data mining

Introduction

As health-care organizations increase their ability to collect and store electronic clinical data, outcomes researchers continue to develop and test novel research designs and analytic methods to better understand quality of care. Researchers have continually demonstrated a link between health–care organizational factors and patient outcomes, which theoretically supports the investigation of the effectiveness of clinical care (Aiken, Clarke, Cheung, Sloane, & Silber, 2003; Estabrooks, Midodzi, Cummings, Ricker, & Giovannetti, 2005; Friese, Lake, Aiken, Silber, & Sochalski, 2008; Tourangeau et al., 2007). Electronic databases compiled by health-care organizations will be important sources of information for evaluating the effects of practice-based interventions.

Informatics approaches and resources are becoming critical to the field of outcomes research. Informatics approaches, such as data mining, are important for enabling knowledge-driven health care based on a solid research foundation (Embi, Kaufman, & Payne, 2009). The use of elec-

tronic clinical databases can provide opportunities to identify comprehensive new evidence from clinical practice and to accelerate knowledge generation. Discovering effective practice patterns through the use of electronic databases will provide empirical evidence of what clinical interventions constitute safe, efficient, high-quality care for patients at risk for problematic conditions such as pressure ulcers. As digital information and communication technologies overtake manual data collection and storage, we need to leverage the strengths of outcomes and informatics research.

This article presents an organizing framework that integrates the Quality Health Outcomes Model (QHOM) (Mitchell, Ferketich, & Jennings, 1998) with the Knowledge Discovery in Databases (KDD) process (Fayyad, Piatetsky-Shapiro, & Smyth, 1996) to guide knowledge discovery from electronic clinical databases to support the conduct of comparative effectiveness research (CER). Our framework is based on the notion that expert practice-based knowledge is critical to (a) identifying clinically relevant interventions based on patient and system characteristics; and (b) facilitating rigorous and efficient knowledge discovery, using electronic clinical databases, that is relevant to the field of outcomes research. We describe the framework and illustrate its application using the example of hospital acquired pressure ulcer (HAPU) prevention.

Outcomes: The End Results of Clinical Care

Outcomes research examines the end results of health-care delivery that takes into account patients' experiences, preferences, and values (Clancy & Eisenberg, 1998). A major challenge in outcomes research has been to balance what researchers *want to* measure and what they *can* measure using existing information systems. Outcomes research involves a range of statistical methods and data collection, including collecting data de novo and drawing on primary studies. Two broad categories of data are relevant to the conduct of outcomes research: (1) patient-specific information (laboratory results, health-care-provider assessments, and other information that can be found in a medical record); and (2) system-specific information (health-care expenditures, staffing, hospital size, etc.). Both patient- and system-level data are needed to contextualize and evaluate relevant measures such as complications, length of hospital stay, health status, and mortality. The goal of outcomes research is to generate evidence pertaining to decisions made by those who participate in health care, including administrators, providers, and patients. Associating differences in the process of care with differences in outcomes can serve to clarify what care is effective or worthwhile as well as where improvements can be made by clinicians and organizations.

Informatics: Facilitating the Use of Electronic Clinical Databases in Outcomes Research

Recent developments and advances in informatics research can enable rigorous outcomes research. A central concern for the outcomes researcher is the aggregation of data from multiple disparate information resources. Informatics platforms and resources used in clinical practice can potentially address data concerns. Integrated electronic health records (EHRs) can be used to collect data on potential research participants and reduce reliance on redundant and error-prone paper-based collection methods (Bates, Ebell, Gotlieb, Zapp, & Mullins, 2003). Moreover, EHR data collected through routine health-care processes can be reused in outcomes research. These data can be stored and maintained in a clinical data warehouse, a type of database or data repository that is designed for data reuse in research (Dewitt & Hampton, 2005). This type of data storage facilitates longitudinal or episodic queries based on more than one criterion of interest, including laboratory, radiology, and pathology results; surgical reports; discharge summaries; demographic information; diagnostic and procedural codes; and operations data, which are especially useful in outcomes research. Initiatives aimed at supporting reuse of data stored in clinical and research warehouses have resulted in the development of query tools to facilitate researcher exploration and extraction of data (Sittig et al., 2012). Moreover, the application of data mining and statistical methods to identify or test hypotheses is common in large-scale data extraction from data repositories. These automated methods can complement rigorous outcomes research by enabling the use of electronic clinical data as well as enhancing the efficiency of large-scale practice-based studies.

Integrating Outcomes and Informatics Perspectives

The Knowledge Discovery through Informatics for Comparative Effectiveness Research (KDI-CER) organizing framework is one approach to the integration of outcomes (i.e., QHOM) and informatics (i.e., KDD) paradigms for the purpose of guiding knowledge discovery for CER. Our approach is sufficiently broad to (1) guide the development of research on what works in clinical practice, (2) provide a framework for outcomes research and knowledge discovery that involves clinicians and researchers across multiple disciplines, and (3) support the diversity of clinical outcomes research. The KDI-CER framework suggests that discovering knowledge about the relative effects of practice-based interventions is an interactive and iterative process informed by expert practice-based knowledge at every stage (see Figure 1).

Figure 1 *Organizing Framework*
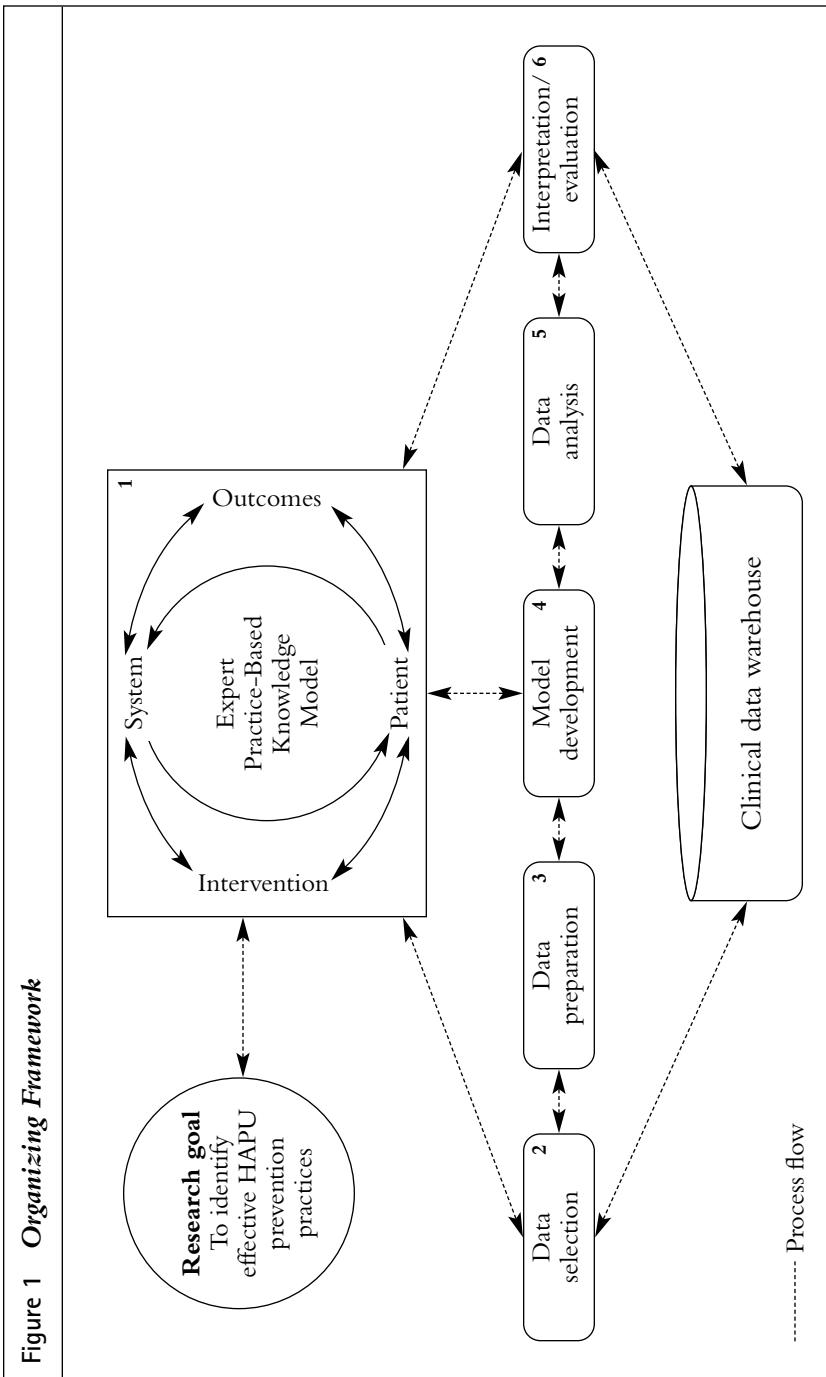
QHOM

The Quality Health Outcomes Model depicts the relationships of four constructs: patients, systems, interventions, and outcomes (see Figure 1, box 1). Mitchell et al. (1998) suggest reciprocal directions of influence between constructs with no single direct connection between interventions and outcomes. The effect of interventions on outcomes is thought to be mediated by patient and/or system characteristics. Interventions are considered direct or indirect patient care, such as the administration of total parenteral nutrition or the provision of culturally appropriate education to increase adherence to a therapeutic regimen. Patient characteristics can include traditional demographic variables, existing health problems, and socioeconomic status measures. The system includes organizational and provider characteristics — for example, hospital bed size or nurses' education level. Thus outcomes are "the results of care structures and processes that integrate functional, social, psychological, physical, and physiological aspects of people's experience in health and illness," which may be individual or organizational measures (Mitchell et al., 1998, p. 45).

KDD

Knowledge Discovery in Databases refers to a human (e.g., researchers and/or clinical experts) supported interactive and iterative process of discovering useful, nontrivial contextualized knowledge from large electronic databases (Fayyad et al., 1996). KDD has typically focused on financial and other business-related databases but is being used increasingly with health-care databases. It involves a number of steps with many decisions made by researchers and/or clinical experts throughout the process. Generally, KDD consists of (1) developing a knowledge model of the clinical domain; (2) creating a target data set; (3) data cleaning and pre-processing; (4) data reduction and projection; (5) choosing the data-mining task (e.g., description or prediction); (6) choosing data-mining methods; (7) identifying and interpreting patterns (or reiterating any of the previous procedures based on the preliminary findings); and (9) documenting and/or incorporating discovered knowledge into practice or policy (Fayyad et al., 1996). KDD can involve numerous iterations of any of the procedures. In health-care research its goal is to generate and/or specify a model that can be tested to confirm the association between explanatory and response variables.

The KDI–CER framework (see Figure 1) harnesses the conceptual and methodological maturity of both the QHOM and the KDD to facilitate knowledge discovery in large clinical databases. Practice-based expert knowledge is one of its critical components. Researchers have

demonstrated that theoretical and pragmatic expert practice-based suggestions in outcome studies enhance knowledge discovery through electronic clinical databases (Gaines, 1989; Wilcox & Hripcsak, 2003). The QHOM is used to motivate clinicians to identify key variables in intervention research and provide direction to clinicians and researchers in developing hypotheses to test during the knowledge discovery process. While there are no theoretical links between the QHOM and KDD processes, the KDI-CER approach depends on data/information about patient and system characteristics and interventions to generate practice-based knowledge from existing data. In contrast to the traditional approach to knowledge discovery (Fayyad et al., 1996), the KDI-CER groups several procedures within one (i.e., *data preparation* includes data cleaning, pre-processing, reduction, and projection; *model development* includes choosing the data-mining task and methods (see Figure 1, boxes 3 and 4). The KDI-CER framework is intended to guide practice-based observational studies of electronic clinical data.

Example: Hospital Acquired Pressure Ulcers

The following describes the process of conducting knowledge discovery based on the KDI-CER organizing framework. The major assumptions of this approach are that (a) knowledge discovery using electronic clinical databases requires the inclusion of clinical expertise about practice-based interventions, and (b) the relative effects of interventions cannot be evaluated without practice-based data.

The Problem

Hospital acquired pressure ulcers are a major cause of morbidity that significantly increases average length of stay, human suffering, and financial costs (Reynolds, 2008). The 2011 HealthGrades Patient Safety in American Hospitals Study reports that HAPU is the second most common patient safety event, after death from treatable surgical complications, among Medicare patients (Reed & May, 2011). Russo et al. (2008) report a 78.9% increase in HAPU occurrence from 1993 ($N =$ 281,300) to 2006 ($N =$ 503,300) for adults 18 years and older. The associated cost in 2006 was $11 billion. The estimated incidence rate for HAPU ranges from 7% to 9% (Whittington & Briones, 2004) and the documented incidence rate for ICU HAPU ranges from 3.8% to 12.4% (Vangilder, Amlung, Harrison, & Meyer, 2009).

HAPU prevention is based largely on expert opinion and/or consensus panels, and not on empirical evidence (European Pressure Ulcer Advisory Panel & National Pressure Ulcer Advisory Panel, 2009). The most conclusive findings on HAPU are related to the identification of

risk factors or validation of pressure ulcer risk–assessment tools (Lyder & Ayello, 2008). A challenge in patient safety research is discovering effective HAPU-prevention interventions. While comprehensive prevention programs based on clinical practice guidelines can reduce overall prevalence rates (Lyder, Grady, Mathur, Petrillo, & Meehan, 2004; Rich, Shardell, Margolis, & Baumgarten, 2009), there is insufficient evidence linking individual risk assessment and clinical care to HAPU prevention.

Discovering HAPU Prevention Interventions in Electronic Databases

In this example, a mixed–method approach is used to discover empirical relationships between practice-based interventions and the prevention of HAPU in electronic clinical databases. A multidisciplinary clinical team comprising practice-based experts (i.e., nurses, physicians, nutritionists, and physical therapists) collaborates throughout all phases of the knowledge discovery process. The research team uses the QHOM constructs as guideposts to engage the clinical experts in an iterative interchange to develop a practice-based-knowledge model of HAPU prevention based on the patient (e.g., comatose) and system characteristics (e.g., nurse staffing) and interventions (e.g., skin care) that are considered important in the prevention of HAPU (see Figure 1, box 1). The robust characterization of patient and system characteristics and interventions can enhance the external validity of empirical findings (Horn & Gassaway, 2007). The research team extracts hospitalizations from the clinical data warehouse based on selection criteria agreed upon by the clinical and research teams. The data from these hospitalizations are used to create a target data set of the patient and system characteristics and interventions (see Figure 1, box 2).

Data–Preparation Stage

The research team evaluates the quality of the data during the data-preparation stage (see Figure 1, box 3). First, the research team creates decision rules for automated methods of converting textual information from unstructured sources such as narrative clinical notes or reports into structured, coded descriptions (Friedman, Alderson, Austin, Cimino, & Johnson, 1994). Next, it creates decision rules to extract structured coded data from its original representation (i.e., multiple database tables) to create a single database table. Each patient record for a hospitalization is represented by a row and the features (i.e., variables) are represented in columns. Organizing the data in this structure reduces hierarchical and nested structuring (Adriaans & Zantinge, 1996). Third, the research team uses various methods to transform the data into a useable form, including data imputation, time-lag specification, and data reduction. Data transformation minimizes the potential for over-fitting the analytic models

(Kohavi, 1995). Many of the cases in the target data set will have missing features. The research team addresses missing data by choosing from among the following data-imputation methods: (1) procedures based on quasi-randomization modes of inference, (2) model-based approaches, and (3) machine learning methods (Lakshminarayan, Harp, & Samad, 1999). Additionally, clinical practices may include time-dependent interventions. In such cases, the research team specifies a time lag to represent the number of previous values that could influence the outcome (Kkantardzic, 2003). Depending on the dimensionality of the data set, statistical (i.e., one-dimension) or visualization (i.e., multiple-dimension) methods are used to conduct outlier analyses (Kkantardzic, 2003). The research team considers whether some data can be discarded to increase computational efficiency without reducing the quality of the data set (Koller & Sahami, 1996). Variable reduction can be based on principal component analysis, values reduction, variable discretization, and case reduction (Kkantardzic, 2003). Finally, the research team considers whether the target data set should be limited further using the information captured in the Expert Practice-Based Knowledge Model (see Figure 1, box 1). However, the team is careful not to over-limit the data set, thereby allowing potentially unknown empirical relationships to be discovered using automated data-mining methods.

After preparing the data for analysis, the clinical practice and research teams combine automated data-mining methods and Bayesian network analyses to estimate the relative effects of prevention interventions. There are a number of factors that make Bayesian networks ideal for knowledge discovery, including use of expert domain knowledge in the discovery process; increased precision and accuracy through the use of encoded knowledge to predict an outcome; adaptability to rapidly evolving interventions (e.g., devices, procedures, and provider or system interventions); and ease of interpretation as compared to other network structure data-mining techniques (Lee & Abbott, 2003). Adaptive approaches, such as Bayesian networks, can be useful for answering pragmatic questions within and across care units and patient populations — for example, "What is the probability that turning a patient every 2 hours is more effective than turning a patient every 4 hours?" or "What is the probability that Practice Model A is more effective than Practice Model B, and vice-versa, for pressure ulcer prevention in Population A versus Population B?"

The research team develops a Bayesian network structure that depicts probabilistic relationships among the patient and system characteristics and interventions identified by the clinical practice team and based on the associations posited in the QHOM. The structure reflects the conceptual relationships of probabilistic knowledge that take the form of a

diagram with nodes (i.e., variables) and arrows (i.e., relationship directions). Based on the specifications of the network structure, the research team applies data-mining methods to a subset of the target data set (i.e., training data) to generate a relational analytic model. The resultant model (see Figure 1, box 4) reveals estimates of the relative effects of interventions and patient and system characteristics on HAPU prevention. The research team cross-validates this analytic model using a random subset of the target data (i.e., test data; box 5). The significance of the analytic model depends on its ability to detect at-risk patients who did not develop a HAPU (i.e., evaluation) and whether the clinical team thinks (i.e., interpretation; box 6) the results are clinically significant. In the long run, the research team will conduct a comparative effectiveness study to examine the differences between HAPU prevention based on the findings from the knowledge discovery process and the usual prevention model.

Implications of the KDI-CER Organizing Framework

The KDI-CER framework is intended to guide investigations into the effects of clinical interventions using electronic clinical databases. There has been limited use of informatics methods for knowledge discovery in health research (Chae, Ho, Cho, Lee, & Ji, 2001; Goodwin et al., 2001; Jakkula & Cook, 2008; Poynton & McDaniel, 2006; Sokol, Garcia, Rodriguez, West, & Johnson, 2001; Zhu, Zhang, Hirdes, & Stolee, 2007), and even less in nursing outcomes research. Knowledge discovery and the conduct of rigorous CER focused on nursing interventions are dependent on high-quality electronic nursing data. The integration of standardized nursing languages (SNLs) in EHRs can support robust knowledge discovery and CER by making available nurses' documentation of interventions and outcomes (Bakken, Stone, & Larson, 2008; Institute of Medicine, 2011). However, nurses must engage in reliable documentation to capture nursing's contribution to patient outcomes. When nurses are not fully engaged in reliable documentation, the analyses of the resulting data for CER are impeded by extensive data preparation, potentially biased information, and increased research costs. The use of SNLs in EHRs can support data collection across populations and settings as well as yield the evidence necessary to support practice-based knowledge discovery and CER (Lunney, Delaney, Duffy, Moorhead, & Welton, 2005; Westra, Delaney, Konicek, & Keenan, 2008).

The ongoing development of health information infrastructures in several countries, including Australia (Department of Health and Ageing, Australian Government, 2010), Canada (Canada Health Infoway, 2010), the United Kingdom (National Health Service, 2010), and the United

States (Yasnoff et al., 2004), as well as the development of EHR databases by large health-care delivery systems, will increase the capacity of informatics and outcomes research (Häyrinen, Saranto, & Nykänen, 2008). These developments will make available integrated health-care information on millions of patient episodes and increase the potential for discovering the effects of clinical interventions on patient outcomes (Liang, 2007). Our framework builds on the strengths of the QHOM and KDD processes by reflecting the various components of care and incorporating practice-based expertise throughout the knowledge discovery process. The KDI-CER framework provides a way not only to conceptualize study designs but also to address methodological limitations imposed by the use of a single research perspective. Organizing frameworks are frequently developed by experts and should be put to the test in terms of practice. Although we have illustrated application of the framework to the example of HAPU, the usefulness of the KDI-CER framework will be fully appreciated when it is applied to real-world electronic clinical data to discover knowledge about the effects of clinical interventions for use in CER.

Conclusion

The KDI-CER framework was conceived as a heuristic for knowledge discovery to support CER. It encourages clinicians and researchers to conceptualize clinical practice from a complex perspective that suggests there is an indirect influence of interventions on outcomes and system and patient characteristics that mediate the effects of interventions on the outcomes of care delivery. This can stimulate the identification of relevant practice-based interventions as well as patient and system characteristics to facilitate knowledge discovery in electronic clinical databases.

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Résumé

Développer une relation avec l'ordinateur dans le cadre de la pratique infirmière : une théorie de terrain

Barbara L. Cross, Marjorie MacDonald

En dépit des preuves d'améliorations que les technologies de l'information peuvent apporter à la pratique clinique, le personnel infirmier a été lent à adopter l'informatique et les systèmes d'information. L'objet de la présente étude a été d'élaborer une théorie de fond sur la manière dont le personnel infirmier intègre les ordinateurs à sa pratique clinique, de même que de recenser les facteurs déterminants. Recourant à une théorie de terrain, les chercheuses ont réalisé des entrevues avec 12 infirmières et infirmiers exerçant dans deux hôpitaux de soins de courte durée, dans la province canadienne de la Colombie-Britannique. Tous les participants se sont engagés à établir une relation avec l'ordinateur dans leur pratique. Ils ont intégré les ordinateurs à leur pratique à des rythmes et des degrés d'adoption variés, en fonction de leurs caractéristiques personnelles, de leur expérience en matière d'ordinateurs, du degré auquel l'informatisation s'accorde avec leurs valeurs, de leur capacité à percevoir les avantages de la technologie et de leur aptitude à appréhender et surmonter les obstacles à l'utilisation de l'ordinateur. Le personnel infirmier a besoin de soutiens organisationnels pour faciliter l'intégration des technologies ainsi que d'une formation à l'informatique dans les programmes d'enseignement de base des sciences infirmières.

Mots-clés : ordinateurs, technologies de l'information, soutiens organisationnels, formation à l'informatique

Developing a Relationship With the Computer in Nursing Practice: A Grounded Theory

Barbara L. Cross, Marjorie MacDonald

While there is evidence that information technology can improve clinical practice, nurses have been slow to adopt computers and information systems. The purpose of this study was to develop substantive theory on how nurses integrate computers into their clinical practice and to identify influencing factors. Using grounded theory, the researchers conducted interviews with 12 nurses practising in two acute-care hospitals in the Canadian province of British Columbia. All participants engaged in developing a relationship with the computer in their practice. They integrated computers into their practice at varying speeds and degrees of adoption, depending on personal characteristics, prior experience with computers, the extent to which computerization was congruent with their values, whether they were able to see the benefits of the technology, and their ability to manage and overcome the barriers to computer use. Nurses require both organizational supports to facilitate technology integration and computer education in their basic nursing programs.

Keywords: computerization, information technology, implementation, nursing

Introduction

Worldwide, information technology (IT), specifically computers and health information systems, are being integrated into many clinical arenas. There is evidence that, when successfully implemented, this technology can significantly improve clinical practice and care delivery (Buus-Frank, 1999; Hebda & Czar, 2009; Lorence, Spink, & Richards, 2002; Mihailidis, Krones, & Boger, 2006; Saba & Westra, 2011). Buus-Frank (1999) suggests that the survival of nursing depends on its embracing of technology, arguing that "as the volume of information increases, the half-life of knowledge is decreasing" (p. 433). Nurses have been slow to adopt computer technology (Simpson, 2003) despite their recognition that technologies are essential tools for both practitioners and administrators (Nagle & Ryan, 1996). When computer technology and information systems are not integrated into nursing practice, patients can be placed at risk, as nurses do not have access to timely information to guide their decision-making. Appropriate use of technology also enables nurses and other care providers to achieve the high output demanded by the

public and governments (Borycki, Lemieux-Charles, Nagle, & Eysenbach, 2009; Hebda & Czar, 2009; Nagle & Ryan, 1996; Simpson, 2003).

Historical Perspective

In 1958 Blumberg suggested that computers could facilitate the automation and streamlining of selected nursing activities to free nurses up for other important tasks (cited in Hannah, Ball, & Edwards, 2006). In the late 1950s there was very little uptake of computers by nurses (Hannah et al., 2006); nursing leaders were not knowledgeable about this "cumbersome technology" (p. 29) and computer companies therefore focused on the business and financial sectors.

In the 1960s and 1970s, however, health-care leaders began to investigate the use of computer technology and software applications in health care. It was during this period that an early version of the electronic health record (EHR) was developed (Staggers, Thompson, & Snyder-Halpern, 2001). Decision-support tools (e.g., online references, communication and messaging solutions) arrived in the 1980s. By the 1990s computer technology was rapidly proliferating (Buus-Frank, 1999). The burgeoning information age was accelerated by the introduction of Web-based functionality, client/server architecture, and advancements in the World Wide Web (Hannah et al., 2006). New and ever-changing information about patients and their care was available to nurses in real time, potentially giving all clinicians the most current and relevant information to support their practice.

Computer technology in clinical settings created opportunities for nurse leaders to use disparate clinical information systems and electronic spreadsheets for purposes such as reporting client-related data, compiling population-based databases, abstracting statistical information, and using electronic mailing and communications applications (Hannah et al., 2006; Hebda & Czar, 2009; McBride, 2006; Staggers et al., 2001). In the setting chosen for the present study, however, few direct-care nurses accessed computer technologies and related clinical information systems. Many factors might explain this phenomenon. One factor could be a lack of understanding by IT departments and nurse leaders of the potential for positive impacts of computer technology and clinical information systems on clinical practice (Hannah et al., 2006; Hebda & Czar, 2009).

Nurses' Attitudes Towards and Perceptions of Computer Technology

When computers were introduced in the field of health care, quantitative methods dominated the research world and were used to measure nurses' attitudes towards computer technology and their computer literacy. Predetermined attributes of nurses were hypothesized to predict acceptance or adoption of computer technology in their practice (e.g., Hillan,

McGuire, & Cooper, 1998; Hobbs, 2002; Jayasuriya & Caputi, 1996; McBride & Nagle, 1996; Scarpa, Smeltzer, & Jasion, 1992; Schwirian, Malone, Stone, Nunley, & Francisco, 1989; Stronge & Brodt, 1985). Many of the early studies suggested that nursing's reluctance to adopt technology was related to negative attitudes towards computers and a lack of understanding of the technology. In other words, the "problem" was the nurses themselves. Using Burke's (1991) Nurses' Computer-Aided Use Questionnaire, Marasovic, Kenney, Elliott, and Sindhusake (1997) found that age, education, previous use, and years of experience influenced nurses' attitudes towards computers and found a strong positive correlation between nurses' adoption of technology and their satisfaction with, beliefs about, and motivation to use technology. Marasovic and colleagues concluded that education should be focused on optimizing nurses' beliefs and motivations. By contrast, studies on the implementation of biomedical technology (Fulton, 1996; Maxwell, 1995) showed that organizational context, implementation design, and diffusion strategies contributed to nurses' adoption of/resistance to biomedical technology. These findings broaden our understanding of influences on the integration of computer technology, from intrapersonal factors to organizational and environmental context, and suggest that organizational strategies might be at least as important as educational strategies.

None of the published studies on nurses' use of computers and IT has qualitatively explored nurses' understandings of and experiences with computer technology; thus we know little about the perceived value of computerization in nursing practice. Although several of the studies described above identify predefined factors that influence computer use by nurses, we were interested in a more nuanced and in-depth understanding of these influences. Almost no research has been done to theorize the process by which nurses manage challenges to the integration of computer technology and the EHR in their practice; we believe that a qualitative study to develop such a theory will make an important and unique contribution to the literature.

The Study

Computerization Initiative

In 2001 a regional health authority (HA) in the Canadian province of British Columbia began phased-in implementation of IT systems in one of its three geographic regions. Computerization initiatives in the HA evolved between 2001 and 2010. At the time of data collection for this study (November 2009 and January 2010), stationary and mobile computers had been incorporated into the clinical setting at both participating tertiary hospitals. The HA had also adopted an EHR comprising an

integrated suite of electronic solutions in a single platform with several applications (e.g., laboratory and radiology results, clinical documentation/transcribed documents, patient demographics). Although computerization and the EHR were later extended to the HA's two other regions, this study focuses on the computer-implementation experiences of nurses in its southern region.

Despite the HA's staged approach to implementation, the uptake of the technology by nurses in particular may have been limited by a variety of factors. First, in the early days of computerization, IT departments were responsible for deployment strategies in clinical areas. Typically, IT specialists engaged minimally with clinical leaders and did not consider the workflow relationships and information needs of clinicians. It appeared that IT staff, mainly computer technicians, had little understanding of the physical space impacts of computers in clinical settings, staff requirements for education in computer and information systems, and the effects on staff of introducing such technologies in terms of their practice and workflow. IT staff appeared not to be aware of the adverse impacts and safety risks associated with the dynamic nature of clinical practice and of the fact that stationary or "fixed" technologies (e.g., desktop computers) might negatively affect information access. Consequently, desktop rather than point-of-care computers were deployed during most of the early computerization initiatives in the HA.

Second, clinical data available in the EHR were also accessible to staff in print format, providing a "parallel" health record. Consequently, many practitioners and staff members continued to rely on paper-based, manual processes to access patient and clinical information. A 2009 internal audit of nurse-user statistics confirmed that fewer than 30% of nurses accessed patient information via the EHR.

Third, despite recommendations to the contrary (Kushniruk, Borycki, Kuwata, & Kannry, 2006; Mihailidis et al., 2006), there were no clearly mandated organizational requirements for nurses to use computers in their practice. In the absence of an organizational mandate, and with the availability of the familiar paper record, nurses had no incentives to use computer technology.

Given this reality, the HA moved to eliminate the parallel paper system, a process that was achieved in early 2010. This change would render the use of computers and the EHR no longer optional. Consequently, the pre-implementation stage provided a unique opportunity to study how nurses integrate computers and IT into their practice. A situation of mandatory computer use could obscure other important factors in the process of adopting the technologies and could limit opportunities to develop and tailor strategies for supporting technology integration by different groups of nurses.

Purpose

The purpose of the study was to develop a theory of how nurses understand and manage the integration of computers and the EHR into their practice and to explore the influences on this process. Our objective was to identify the barriers to and enablers of computer integration with a view to developing strategies to help nurses incorporate this change into their practice. We anticipate that the results of the study will help to improve and automate nurses' clinical care processes, which in turn will facilitate more accurate, informed, and timely patient-care decisions and result in quality-based efficiencies in care delivery.

Methodology

We used grounded theory (GT) methodology (Glaser & Strauss, 1967), a qualitative, inductive approach, to construct substantive theory about the process by which nurses manage the integration of computers into their practice. Grounded theorists do not set out to test a preconceived theory; rather, they start with an area of inquiry or a research aim and allow whatever is theoretically relevant to emerge from analysis of the data (Strauss & Corbin, 1998). Ultimately, a theory or conceptual framework is generated that explains the actions under study as well as the social and/or structural conditions that influence these (MacDonald, 2001).

Ethics approval for the study was obtained from the joint Research Ethics Board of the HA and the university.

Sample

In GT, sampling is purposive, to identify participants who have experience with the phenomenon under study (Schreiber, 2001). The selection criteria were as follows: (1) practising registered nurse, (2) 6 months' nursing experience, (3) currently providing direct care to patients and families, (4) have access to computers and use biomedical technology, and (5) work in clinical areas in one of the two major acute-care facilities in the southern region of the HA. A total of 12 registered nurses participated — 11 female, one male — from a variety of clinical settings that had moderate to high technology use (e.g., renal, cardiac, medical-surgical). Their ages ranged from 26 to 60 years ($M = 45.9$) and their nursing experience ranged from 1 to 40 years. One held the position of clinical nurse educator and the remaining 11 provided direct acute care.

Nurses were recruited using posters in the clinical areas being targeted. Because the first author was the regional manager of clinical informatics in the HA, there was potential for nurses to perceive a power-over relationship and feel some coercion to participate. To mitigate this risk,

we used a third-party recruiter to receive expressions of interest, meet face-to-face with prospective participants, describe the study, assure the nurses that participation was voluntary, and obtain informed consent. Once a nurse agreed to participate, she or he was referred to the principal investigator (PI), who arranged and conducted all the interviews.

Data Collection

Data collection in GT is conducted concurrently and in tandem with analysis, which involves coding, memoing, theoretical sampling, and sorting (Charmaz, 2006; Glaser, 1998; Schreiber, 2001; Strauss & Corbin, 1998). All 12 interviews were audiorecorded, transcribed verbatim, and uploaded into NVIVO 8 for analysis. After each interview, the interviewer wrote field notes, memoed her observations and interpretations of the interview, and identified opportunities to explore emergent themes during subsequent interviews.

The PI conducted semi-structured, 1-hour, face-to-face interviews with participants. She asked six open-ended questions, adding probes as necessary to obtain more depth or clarification. Questions focused on participants' experiences of using computers and biomedical technology in their practice, the value computers that added to their practice, challenges of integrating computer technology, how they learned about using new technology, and beliefs about the relevance and utility of computers and technology in their practice.

Data Analysis

The database consisted of the audiorecordings, transcriptions, field notes, and interviewer memos. We used standard grounded theory analytic techniques (Charmaz, 2006; Glaser, 1978; Strauss & Corbin, 1990, 1998). Analysis began immediately after the first interview with open or line-by-line coding in which labels or codes, primarily derived from participants' own words, were applied to chunks of data.

Using the constant comparative method (Glaser, 1978), we proceeded with coding by comparing incident to incident, incident to concept, and concept to concept, moving the analysis to higher levels of conceptualization. As concepts accumulated, they were grouped into categories based on their shared properties or dimensions. Thus analysis proceeded by building on early categories to create higher-order categories until saturation of each category was reached — that is, until no new codes emerged from the data.

Between the third interview and the sixth, after considerable line-by-line coding, more focused or selective coding was used to flesh out the concepts and categories. The process of selective coding goes beyond line-by-line coding to create more "directed, selective, and conceptual

codes" (Charmaz, 2006, p. 57). Through theoretical sampling (Glaser & Strauss, 1967), emerging conceptualizations informed the direction of the remaining interviews and comparisons. Then we began the sorting, a process that involves "sorting, diagramming and integrating materials" (Charmaz, 2006, p. 115). This moved the analysis to the level of theorizing, and attention shifted to exploring the data for relationships among the concepts.

We used Strauss and Corbin's (1998) conditional/consequential matrix to help identify the conditions at various levels that influenced particular actions and their consequences. The above analytic processes resulted in a diagram of the emerging categories and the relationships among them (not included here). At this stage in the analysis, we recognized the importance of nurses finding meaning through the use of computers in their practice. Other categories that emerged at this point were barriers to and benefits of computer integration as well as similarities and differences in participants' use of biomedical and computer technology. The analysis also revealed the existence of two distinct groups of nurses in terms of computer-integration experiences.

Additional theoretical sampling and more selective coding were used to flesh out and revise these early categories and develop the relationships among them. We identified the importance of nurses' prior experiences with computers, biomedical technology, learning, and organizational and professional discourses in relation to computer integration. The category of Contextualizing Values emerged to demonstrate that successful adoption of computer technology was influenced by the extent to which nurses perceived that the technology conformed to their values with respect to their nursing practice. The categories of Managing the Barriers and Realizing the Benefits evolved beyond barriers and benefits to a richer understanding of how these processes were handled by participants and the relationship of these categories to whether and how they adopted the technology. The relationships among all of the categories depended on the extent of the nurses' practice experience. The above analysis resulted in a diagram and a preliminary theoretical framework (Figure 1), which outlined the process by which nurses managed the integration of computers and the EHR into their practice and led to the development of the final conceptual framework, as described below.

Findings

A fundamental assumption of grounded theory is that participants share a problem or concern and that they engage in a social–psychological process to resolve it (Schreiber, 2001). The main concern of the participants in this study was the change to their way of managing and provid-

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Figure 1 **Early Depiction of Grounded Theory**
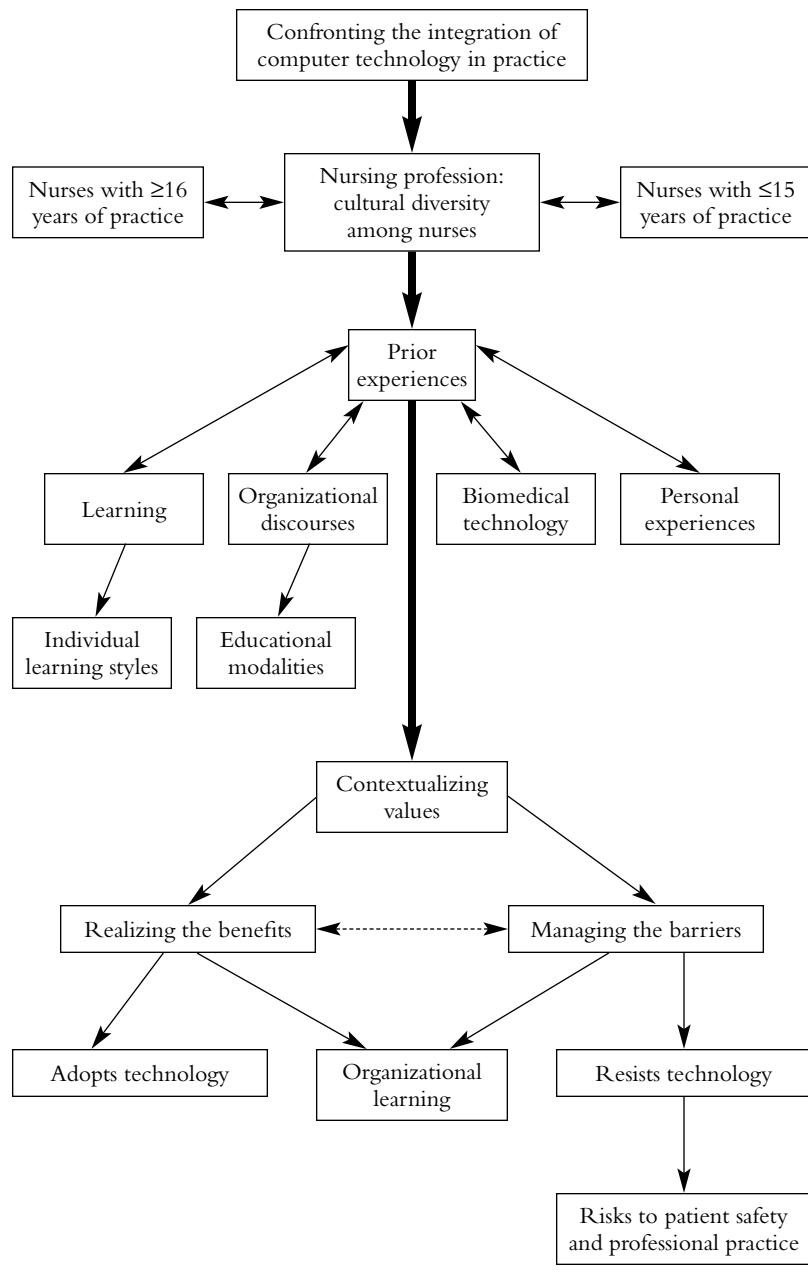
ing patient care as a result of computerization and the introduction of the EHR. To manage this change, nurses needed to develop a relationship with the computer. Thus, the core category that emerged in the analysis was the basic social process of Developing a Relationship With the Computer in Nursing Practice (see Figure 2). To avoid confusion about the level of the concepts and categories in the description below, a different font is used to identify each concept level in the theory. The six higher-order categories are written in bold. Level two codes are written in bold italics. Level three codes are italicized.

The process of Developing a Relationship With the Computer in Nursing Practice consists of six categories: **confronting computerization; reflecting on prior experiences; synthesizing values; realizing the benefits; managing the barriers;** and **adopting, adapting to, or ignoring the computer.** In standard grounded-theory fashion, each of these categories has several subcategories, which, in turn, have other subcategories. These concepts and categories are interrelated and represent a linked set of stages through which participants progress to develop a relationship with the computer such that they are able or unable to integrate the computer into their practice with the goal of providing timely, high-quality nursing care.

How nurses moved through this process was generally dependent on which of two distinct groups they belonged to. The first group (G1) had considerably more years of practice experience. They valued staying in close proximity to their patients, hesitating to leave the patient in order to access a computer. They relied more on the patient than on technology to obtain information for decision-making. They had less trust in technology and had difficulty making the transition to new and different technologies. The second group (G2) had less practice experience and were more likely to have grown up with or used computers extensively. They viewed computers and information systems as important to their practice. They saw computerization as providing timely, accurate patient data and as a clinical tool they could not live without. They trusted technology and were more reliant on it.

Confronting computerization represents the initializing event when computers were introduced into the clinical areas at the HA. The intention was that computers be used for a variety of purposes, including tracking laboratory and diagnostic test results, reviewing patient records and various reports, obtaining electronically generated information about conditions and treatments and policies and standards, and reviewing other clinical documentation. At the time of the study, there was no capability for data entry by the participants. Computerization evoked different responses that, as a rule, depended on the nurses' group membership. The nature of the response influenced the nurses' ultimate use or non-use of

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Figure 2   *Developing a Relationship With the Computer*
in Nursing Practice: A Grounded Theory
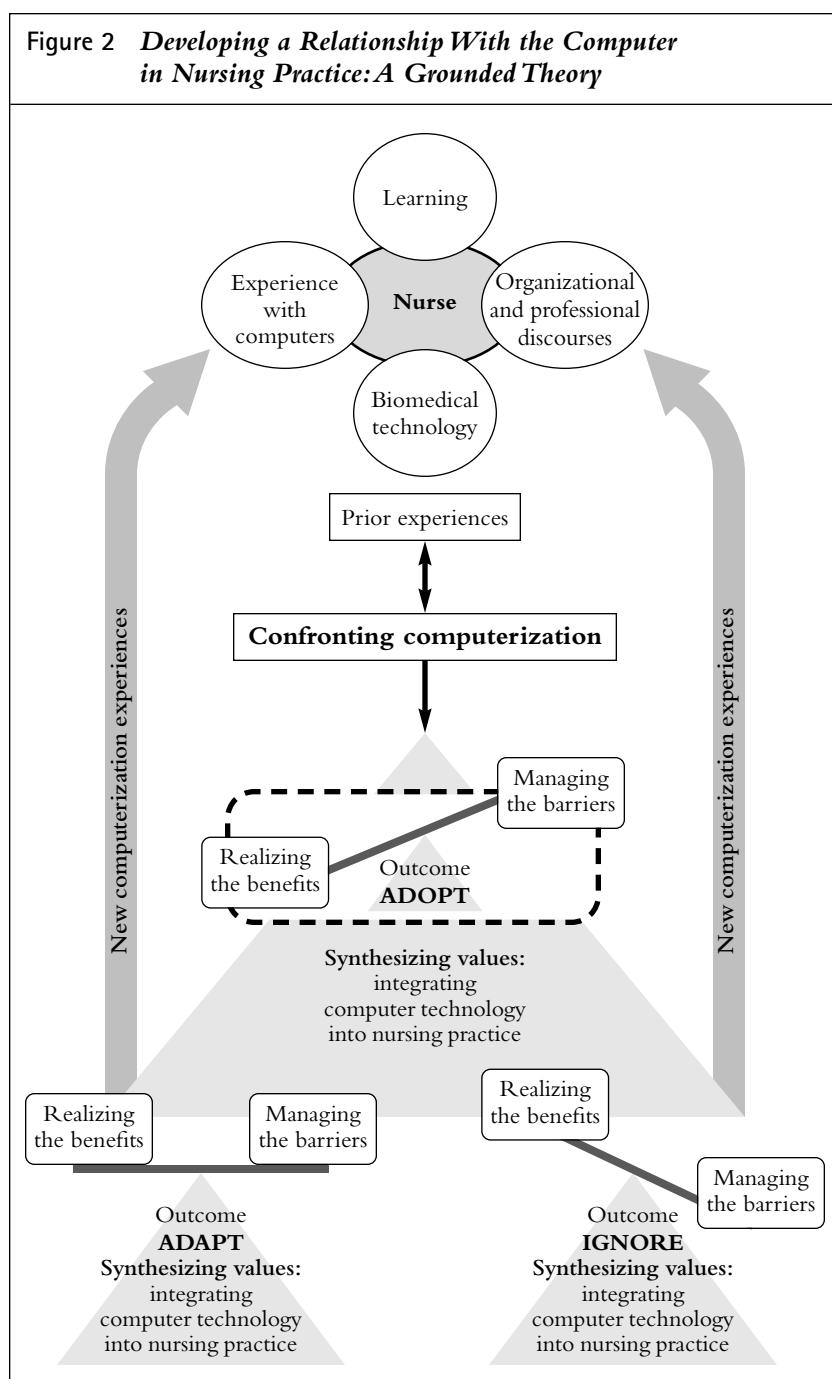
computers and the EHR. Responses included ***reacting to the technology, getting on with it,*** and ***getting stuck.*** In ***reacting to the technology,*** participants expressed a range of negative and positive feelings about computerization. On the negative side, they reported *feeling intimidated* because they had never used a computer before or because they were unfamiliar with information systems in general and thus did not feel confident about seeking the information they needed (G1); *feeling frustrated* by their lack of choice about when to use the computer (G1), how they learned about the computer (G1 and G2), or because the HA was so far behind other organizations with respect to IT (G2); and *feeling overwhelmed* by the workload, which involved "taking on one more piece of unfamiliar technology" (G1).

On the positive side, some participants reported *feeling enthusiastic* about using computers in their practice (G2) and were eager to get on with it. In ***getting on with it,*** the enthusiasts (G2) moved swiftly to incorporate computers and the EHR into their practice and were more likely to make full use of the range of resources offered by the EHR and HA systems. G1 nurses tended to take longer to move beyond the initial confrontation with the computer and instead of ***getting on with it*** often reported ***feeling stuck.*** Those who felt stuck wanted to use the computer but lacked the confidence or skills to log on and/or to access the information in a timely manner. As a result, they would revert back to the paper record for patient/clinical information and, if they used the computer at all, tended not to make full use of the EHR capabilities. These G1 nurses felt intimidated by the computer, frustrated in their attempts to use the computer, and overwhelmed by the demands of learning about computers while attempting to do their work.

The confrontation with computerization also triggered **reflecting on prior experiences** with computers, learning, biomedical technology, and organizational–professional discourses. These experiences influenced how the nurses confronted computerization in their practice. Participants who had had positive experiences with computers, biomedical technology, or learning about computers were more likely to embrace computers, accept new computerization initiatives at the HA, and express motivation and willingness to try new experiences with computer technology (G2). A prior experience was positive for participants when the new technology enhanced rather than impeded their practice and when it was consistent with their values about nursing practice; it was negative when the opposite was true.

Those who reported negative prior experiences were more likely to resent having to use computers, be intimidated by computers, see no need to learn more about computers, or be less motivated to try new computer experiences (G1). In addition, they reported *ignoring the com-*

puter as a coping response to control the pace of learning about or incorporating the computer into their practice or to have some control over the "change" requirements in their practice.

Education and training experiences in biomedical or computer technologies strongly influenced how nurses confronted computerization. Nurses who perceived a need to learn and had the time to learn were more likely to report that their prior learning experiences helped them become knowledgeable and comfortable with the technology (G1 and G2). Some G1 participants felt intimidated learning with their more computer-literate colleagues, while others found it difficult to "absorb" the education provided away from the clinical area because it was not as "familiar" or as "hands on" (G1). Overall, positive learning experiences with computers and technology were likely to contribute to nurses' motivation and willingness to incorporate the computer into their workflow (G1 and G2).

Finally, participants' prior experiences with organizational and professional discourses could positively or negatively impact their ability to engage with the technology and obtain the desired education and support (G1 and G2). ***Organizational discourses*** refers to policies and procedures, implementation strategies for computer and biomedical technology, and related organizational structures and processes. For some participants, the organization's discursive structures and processes, which were intended to facilitate and support computerization, had the opposite effect, resulting in feelings of frustration, mistrust, and concern. Reconnecting with these earlier experiences and feelings affected participants' perceptions of new or upcoming computerization initiatives, raising new questions, concerns, or doubts in their minds (G1 and G2). On the other hand, some participants declared that the organizational processes helped them to use computers and that this enhanced their willingness to embrace the new technology.

Professional discourses refers to participants' experiences with the relationships and tensions between themselves and the "other" group of nurses (i.e., G1 vs. G2). Participants indicated that there was sometimes tension between the two groups. G2 nurses perceived that G1 nurses placed demands on them to help, support, and mentor G1 nurses when they had their own work to do; G2 nurses found this frustrating and unnecessary. G1 nurses perceived that G2 nurses were too trusting of the technology and that they should be willing to provide computer support for their G1 colleagues. At the same time, all participants reported some positive support and mentoring experiences. These experiences influenced how nurses moved through the rest of the basic social process of Developing a Relationship With the Computer.

Synthesizing values is the third stage in the process of Developing a Relationship With the Computer in which nurses connect with their practice values. This process was triggered by **confrontation with computerization.** In managing the requirement for computerization, nurses consciously recalled a particular value underlying their nursing practice: to provide safe patient care. The more that participants felt connected to and aware of their core nursing values, the more they were able to make meaning of and comprehend the relevance of computerization in their practice. Thus *finding relevance* and *finding meaning* were the processes nurses explored in which their core values were expressed as the imperative to preserve the nurse-patient relationship when providing care (G1 and G2).

In *finding meaning* in computerization, participants' identified the conditions for safe and appropriate patient care that must be in place for them to adopt or adapt to computers in their practice — that is, a commitment to using computers in practice requires certain conditions grounded in nurses' values about practice: (1) relevance — all patient and decision-support information must be clinically relevant based on the needs of patients/families and must contribute to patient care; (2) ease of access — accurate information and computer technology must be readily accessible at or near the point of care, with easy processes for logging on and off, and the type of computer technology must be easily incorporated into their practice and workflow; (3) education and support — there must be adequate *time to learn* in a way that is congruent with their learning style; *time to synthesize; time to "take it all in";* and *time to know* where and how to find human, technological, and informational resources; (4) enhanced nursing knowledge/practice — any automation of processes must be perceived by nurses as contributing to nursing practice, reducing duplication of effort, providing best practice/decision supports, augmenting knowledge, defining practice process redesign, ensuring patient safety, and allowing for entry of clinically relevant patient information; (5) clear vision of impending change — nurses accept change as inevitable in their everyday work but want to be part of the vision, to have opportunities to express opinions/ideas/concerns, and to have assurance that workflow and practice nuances will be acknowledged and incorporated into the change.

If participants perceived that all of these conditions were in place during the computerization initiative, they were more likely to *find meaning* in the initiative. They were more receptive to the change and motivated to **realize the benefits** of computerization and more able to **manage the barriers** to seamless integration of the computer in their practice. Although both G1 and G2 participants went through the process of **synthesizing values,** those who had more prior computer experi-

ence (G2) were able to engage with their practice values immediately and at a faster rate; those who had less prior computer experience (G1) needed more time to synthesize the values and *find relevance and meaning* in the computerization initiative.

Realizing the benefits and **managing the barriers** are the fourth and fifth stages in developing a relationship with the computer. These two processes occur concurrently and interactively. Whether participants were open to the benefits of computerization depended on both their prior experiences and their process of synthesizing values. Benefits included having timely, point-of-care access to clinically relevant information and knowing how to search for information that added to their knowledge about patient care needs. This in turn enhanced their ability to make safe, appropriate care decisions.

While nurses were realizing the benefits, they were also struggling to overcome the barriers impeding the integration of computers in their practice. Once they identified the barriers, they began to seek ways to eliminate or work around them. Participants who realized the benefits early in the implementation period were able to be more strategic about managing the barriers (G2). Those who were more adept at managing the barriers (G2) became early adopters and peer champions in their respective clinical areas.

Realizing the benefits involved two processes: *experiencing the value of computers in practice* and *gaining computer proficiency.* As they began to use computers, participants discovered that computers improved their nursing practice and their patient care. They were able to explore new knowledge, practice, and workflow realities associated with computer technology, with resultant enhanced ability to provide safe, timely, and informed care. They discovered efficiencies offered by automation and readily accessible evidence-based data in their point-of-care computers and thus the value of computers. The more they were able to connect with their core values about practice in relation to patient care, the more they appreciated the positive contributions of computerization to the nurse–patient–technology relationship. The more participants used computers to resolve practice problems and answer their questions, the more computer-proficient they became. Both G1 and G2 nurses went through this process, but G2 nurses experienced the value of using computers and gained proficiency at a faster rate.

In **managing the barriers,** participants navigated the myriad obstructions that adversely impacted their ability to use the computer. These included particular organizational processes, knowledge gaps, aspects of care that made it difficult for them to use the computer, lack of computer skills, and not having timely access to computer technology. These barriers ultimately made it difficult for participants to realize the

benefits of the computer in the nurse–patient–technology relationship. Participants went through two processes in managing the barriers: ***confronting the challenges*** and ***succumbing to the barriers.***

In ***confronting the challenges,*** participants tried to overcome the barriers by exploring a variety of options. These included *dealing with it*, *minimizing the fear,* and *feeling motivated to confront the barriers*. In exploring the options, they described *finding new ways, finding work-arounds,* and *practising with the computer.* These strategies for managing the barriers to computer integration were more likely to be reported by G2 nurses.

G1 participants were less able to confront the challenges and some found themselves ***succumbing to the barriers,*** which they described as *losing the battle, feeling no choice, unable to find meaning, retaining old ways,* and *making practice decisions based on outdated information*. These experiences reflect participants' emotional connection to situations of feeling pressured or being forced to use the computer, irrespective of whether they felt confident or able to appreciate the value and meaning of the technology. *Retaining old ways* and *making practice decisions based on outdated information* were strategies used by G1 nurses to control the pace of change associated with the introduction of computers in their practice, despite the risks associated with relying on outdated information.

The process of Developing a Relationship With the Computer concludes with the nurses' decision to **adopt, adapt to,** or **ignore** the computer in their practice. These outcomes are distinctive for each of the participants and are dynamic, meaning that the outcomes could change with the introduction of any ***new computerization experiences*** and the cycle would begin all over again with potentially different outcomes. In fact, many participants did transition from a state of ignoring to a state of adapting to or adopting.

At the time the computerization initiative was introduced in the HA, none of the 12 participants ignored the computer altogether, although some reported having done so previously. Two nurses had just begun to synthesize the value of integrating the computer into their practice toolkit and had not yet reached a definitive outcome. Three had made significant advances with computerization in their practice, reflecting various stages of adaptation. The remaining seven had adopted the computer in all aspects of their practice. Interestingly, the adopters included G1 as well as G2 nurses. The cyclical and ongoing process of developing a relationship with the computer is what explains what might appear to be an anomaly in the findings. In fact, one of the oldest and most experienced nurses in the sample was one of the best clinical resources for nurses in her area. She had fully adopted computerization in her practice and saw herself as a true advocate and mentor for automation.

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Table 1 *Adopt, Adapt, or Ignore*		
Adopt	**Adapt**	**Ignore**
Embraces computer technology; goes online whenever information is needed	Realizes some of the benefits of computer technology by accessing selected resources online	Continues to rely on paper and automated printing of information
Accesses all patient/clinical information that is available online	Is selective about when to use the computer for information; paper continues to be first choice	Depends on others to look up information online and print it out
Retrieves patient information from the computer first rather than from the paper record	Verbally supports computer technology at the point of care or in the clinical area	Rationalizes reliance on paper by pointing to lack of accessible and functioning computers
Searches online for decision-support information and adds to Favourites	When not overwhelmed with care demands, seeks assistance from peers with accessing information online and learning about clinical information systems	Continues to access information, policies, and procedures from outdated print manuals and textbooks
Ensures that computer is functioning at all times; participates in technological quality control and views the computer as integral to care delivery	Is inconsistent in ensuring that computers are functioning at all times; depending on prioritization of patient care needs, will use print or telephone resources to augment care delivery	Does not advocate for or express support for computer technology at the point of care or in the clinical area
Engages with others to learn from or to mentor clinical colleagues and others; takes the time to demonstrate new personal learning about computers/clinical resources/electronic health record	Selects mentoring opportunities based on knowledge of and confidence in computer technology and/or clinical information systems	Does not seek new learning opportunities related to computer technology or clinical information systems

The extent to which nurses would adopt, adapt, or ignore varied according to their perceptions of computer technology and/or their personal experiences with incorporating computer technology into their practice. Table 1 presents behavioural examples of these three attitudes towards technology. To **adopt** is "to take by choice in a relationship, to take up and practice or use."[1] This is the most straightforward outcome, with no sub-processes. To **adapt** is "to make fit," to strike a balance between traditional paper-based practices and new computer-based practices. Participants embraced the nurse-patient-technology relationship at selected times during their practice, when they felt confident and comfortable using the computer to access information. When they did not feel comfortable and confident, or when they needed to focus exclusively on the patient, they chose to ignore the computer or wait for a colleague to access online resources. To **ignore** is "to refuse to take notice of; to reject." Participants tended to ignore the computer at times of increased stress, heavy workloads, or complex or competing priorities in the provision of direct care. Some ignored the computer when they were questioning its value or were not yet able to give *relevance* and *meaning* to the nurse-patient-technology relationship (G1). The process of ignoring therefore is a transitional or intermittent experience while nurses continue to incorporate ***new computerization experiences.***

Discussion

This study presents the first grounded theory in the literature that describes the experiences of nurses integrating computer technology into their practice. Although several studies identify the key factors influencing computer adoption (Alquraini, Majeed, Shah, & Chowdhury, 2007; Nkosi, Asah, & Pillay, 2011), which are supported by our findings, there are no studies exploring these factors in the context of the personal experiences of nurses confronting computers in their practice. This study, therefore, contributes some unique insights to the literature.

Distinct Groups With Different Experiences

No other study identifies two unique groups of nurses, each with distinct experiences in developing a relationship with the computer, and thus with distinct learning needs and requirements for support. Organizations tend to put "one size fits all" training and resources into place to support computerization initiatives. Our findings suggest that strategies tailored

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[1] Our definitions for "adopt," "adapt," and "ignore" are taken from *Merriam-Webster online: Dictionary and thesaurus* (http://www.merriam-webster.com/dictionary).

to the unique needs and experiences of distinct groups of nurses might ensure a more successful implementation process.

Expert nurses (Benner, 1984; Benner & Tanner, 1987), with years of tacit, intuitive knowledge and first-hand clinical experience with patients, families, and biomedical technologies, have an opportunity to share their expertise with their less experienced colleagues. At the same time, today's nurses enter the profession with an abundance of computer experience, and even informatics competencies, and thus with knowledge and expertise to share (Courtney, Alexander, & Demiris, 2008; Saranto & Leino-Kilpi, 1997; Smedley, 2005). Frontline mentoring is an ideal way to address just–in–time clinical tasks such as searching online for clinical resources, accessing and navigating the EHR, or determining how best to incorporate computer technology. However, organizations also need to consider strategies for building capacity and rewards for mentoring, not only to capitalize on the skills and abilities of each group in order to facilitate technology integration, but also to address the demand for peer support imposed by one group of nurses (G1) on their more computer-savvy peers (G2).

The Age–Experience Chasm

The two cohorts of nurses were quite different with respect to their years of practice experience and their computer experience. Both groups went through the same stages in Developing a Relationship With the Computer. Although they varied with respect to how each stage played out, the focus of their actions, and the factors influencing those actions, the final outcomes were not determined exclusively by group membership. It is tempting to reduce the years of practice experience to age, assuming that older nurses will have more years of practice experience and less computer experience, since they did not grow up using computers. In fact, much of the early research on nursing uptake of computers reports age as an important predictor (Hillan et al., 1998; Hobbs, 2002; Jayasuriya & Caputi, 1996; Marasovic et al., 1997; McBride & Nagle, 1996; Murphy, Maynard, & Morgan, 1994; Scarpa et al., 1992; Schwirian et al., 1989).

However, the relationship between age and experience is not universal. Data from the Canadian Institute for Health Information (2010) show that more individuals are entering nursing as a second career or as part of a late career path. The average age of entry into the workforce has risen, and regulated nurses today are often 30 or older when they graduate and embark on their nursing career (Fessele, 2009; Hatcher et al., 2006; Letvak, 2003; Med-Emerg Inc., 2005; Sherman, 2006). Thus, we cannot assume that age is a reliable predictor of computer adoption.

Challenging the Critique of Technology

Some authors have suggested that technology disrupts the nurse-patient relationship and threatens to diminish the meaning of the patient experience (Locsin, 2001; Malone, 2003; Sandelowski, 1999, 2002). We believe that this is an outdated perspective. It perpetuates the unrealistic view that a bedside vigil alone is sufficient in today's high-acuity and complex care environments. Even the participants in the present study, who tended to rely more on the patient than on technology for their information (G1), acknowledged that without timely access to vital patient and supporting clinical information, patient care may be compromised.

Conditions Essential for Nurses to Adopt Computer Technology

This study makes an important contribution to the literature by identifying the set of value-based conditions necessary for nurses to integrate computerization into their practice. Some of these conditions are not new to us; what is new is the finding that the conditions are closely tied to the values that nurses hold with respect to their practice. It is not sufficient that technology and information be easily accessible, or that adequate education and support be in place. For computers and information systems to be embraced by nurses, their deployment must be congruent with nurses' practice values with regard to the needs of patients and their families — wherever they may be — while contributing to safe and effective practice and improved patient outcomes.

All of this means that health authorities must ensure that "nursing intelligence" is embedded in their EHRs — that clinical data are not only representative of the patient but also reflective of the nurse's "role in relation to the patient" (Alpay & Russell, 2002, p. 137). Nursing intelligence is realized when data reflect nursing knowledge and nursing's purpose in engaging with the patient; data elements support nurses' ability to conduct patient assessments effectively; there are opportunities for more collaborative (i.e., interprofessional) care planning and coordination; nurses have a say in patient assignments and workloads; and nurses have easy access to clinical decision-support tools that augment nursing knowledge. Only then, argue Goorman and Berg (2000), will nurses value the clinical and professional relevance of computer technology and, ultimately, adopt it in their practice.

Implications for Nursing Education

Computerization in the clinical practice arena calls for 21st-century nurses to be knowledgeable about computers and ready to use their computer skills in a fast-paced, knowledge-intensive, patient-centred environment. This is not a new imperative. However, it will not be met

unless nurses acquire computer skills and computer-integration experience in their basic nursing programs and are offered ongoing support and education in the workplace (Chang & Daly, 2001; Randall, Mitchell, Thompson, McCaughan, & Dowding, 2009; Saranto & Leino-Kilpi, 1997; Smedley, 2005). If nurses are exposed to computer technology prior to entering the practice environment, they will feel more at ease in the workplace searching for online information, using clinical information systems, and incorporating this technology into their everyday practice (Fetter, 2008; McNeil, Elfrink, Beyea, Pierce, & Bickford, 2005).

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Résumé

La situation de l'intégration de l'informatique au programme de baccalauréat en sciences infirmières : une étude systématique

Manal Kleib, Oksana Zimka, Karin Olson

L'objectif de la présente étude était de dresser un portrait des résultats des recherches et autres projets concernant l'intégration de l'informatique dans les programmes de formation pour l'obtention du baccalauréat en sciences infirmières (B.Sc.Inf.), et de mettre en évidence les répercussions de cette intégration sur la formation et la recherche. L'examen systématique de la littérature sur la question mené par les auteures couvre la période de 1990 à 2011 et exclut les articles portant sur les étudiantes et les étudiants d'un niveau autre que le baccalauréat et sur les infirmières et les infirmiers déjà en exercice. Sur un total de 440 articles repérés, 53 ont été jugés comme répondant au critère d'inclusion établi pour l'étude, nombre auquel les chercheuses ont ajouté 21 autres articles en fonction de listes de mots clés de référence. L'examen des articles ainsi retenus a permis de constater des écarts quant à l'attention et au temps accordés à l'informatique dans les programmes de formation pour l'obtention du B.Sc.Inf., et quant aux stratégies déployées pour l'intégration de celle-ci. Les principaux problèmes cernés par les auteures sont une absence d'uniformité dans l'intégration des contenus en informatique et un manque d'études rigoureuses sur le processus et les résultats d'une formation en informatique. Il est donc nécessaire que les recherches se poursuivent afin de préciser, dans un premier temps, le contenu de base en informatique que doit comporter la formation de niveau baccalauréat en sciences infirmières, et d'effectuer, dans un deuxièmement temps, une évaluation systématique des effets de cette formation.

Mots clés : informatique, baccalauréat en sciences infirmières, programmes de formation, intégration des contenus

Status of Informatics Integration in Baccalaureate Nursing Education: A Systematic Review

Manal Kleib, Oksana Zimka, Karin Olson

The purpose of this study was to map out results of research studies and other projects on the integration of informatics into BScN education and to highlight implications of this work for education and research. The systematic review of the literature from 1990 to 2011 excluded articles reporting on non–BScN students or nurses already in practice. A total of 440 articles were found, 53 of which were eligible for inclusion in this review; 21 articles were added based on reference lists of key works. Integration of informatics into BScN education was found to vary in terms of focus, duration, and strategies used. The main issues identified were inconsistent integration of informatics content and lack of rigorous research studies on the process and outcomes of informatics education. More work is needed to specify the core informatics content needed in BScN education, followed by a systematic evaluation of the effect of this education.

Keywords: nursing informatics, informatics, baccalaureate nursing students, curriculum integration

Inadequate informatics education affects the ability of graduate nurses to understand how informatics relates to patient care and nursing practice. Institutions charged with the education of health professionals have a responsibility to ensure that students acquire this knowledge (Canadian Association of Schools of Nursing [CASN], 2012). Nevertheless, the literature on the topic is limited and educational outcomes have not been tracked. This review was designed to address the gap. Its purpose was to map out the results of studies and other projects that have focused on informatics in baccalaureate nursing education and to highlight the implications of this work for education and research.

Literature Review

Defining Health Informatics and Nursing Informatics

Health-care informatics (HCI) is "the study of how health data, information, knowledge, and wisdom are collected, stored, processed, communicated, and used to support the process of health care delivery to clients and for providers, administrators, and organizations involved in health care delivery" (Englebardt & Nelson, 2002, p. 528). As an umbrella term,

HCI encompasses the various subspecialties of informatics, such as medical, nursing, and dental informatics. The development of these sub-specialties enables better understanding of how information and communication technologies (ICTs) can be employed to meet the information needs of various disciplinary groups. Nursing has been among the first disciplinary groups to embrace informatics. According to Staggers and Bagley-Thompson (2002), nursing informatics (NI) "facilitates the integration of data, information, and knowledge to support patients, nurses, and other providers in their decision-making in all roles and settings . . . through the use of information structures, information processes, and information technology" (p. 260). Because nurses work in a multidisci-plinary health-care environment, they benefit from both a general under-standing of HCI and a more focused understanding of NI.

Enhancing Informatics Preparedness Among Nurses

Concerns about quality of care and patient safety have been key drivers of the increased interest in improving informatics competencies among health-care providers, especially nurses. Initiatives in these areas, such as TIGER (Technology Informatics Guiding Education Reform) and the Clinicians in Training initiative by Canada Health Infoway and CASN, are currently under way to accelerate informatics capacity-building among nurses and nurse educators (CASN, 2012; Weaver & Skiba, 2006). The American Association of Colleges of Nursing (2008) has mandated that graduates of BScN programs possess competence in informatics upon entry to practice. In Canada, the Canadian Nurses Association (2006) has affirmed that nurses' utilization of ICT is important for improving health-care and patient outcomes and therefore nurses should develop competence in ICT, have access to health information systems, and participate in decision-making related to investments in information technology.

Informatics Competencies

In professional education, the word "competence" is often used to denote performance expectations. A competency-based approach has been pro-posed for teaching informatics to nurses. Specifying informatics compe-tency expectations for nurses guides the integration of these competen-cies in undergraduate and graduate nursing education as well as the pursuit of professional development through continuing education (CASN, 2012; Staggers, Gassert, & Curran, 2002).

A number of NI competencies have been proposed in the literature. The most commonly cited are those proposed by Staggers et al. (2001, 2002) in the United States. In this model, competencies are outlined in relation to the nurse's level of practice — novice nurse, experienced

nurse, informatics nurse specialist, informatics innovator. For each level, Staggers et al. (2002) propose a set of behaviours that nurses must display in order to meet the standard of competence. Recently, CASN in collaboration with Canada Health Infoway published *Nursing Informatics: Entry-to-Practice Competencies for Registered Nurses* (CASN, 2012). The Canadian model identifies an overarching competency that emphasizes proper use of ICT in the context of patient care and professional practice and three specific competencies with a set of indicators for each: (1) information and knowledge management, (2) professional and regulatory accountability, and (3) use of ICT in the delivery of care. Computer literacy is considered a foundational skill that candidates should possess upon entry to nursing programs.

Integration of Informatics Competencies in Baccalaureate Nursing Education

In spite of the availability of NI competency lists, the utilization and integration of informatics concepts in BScN curricula are still not fully developed (Nagle & Clarke, 2004; Thompson & Skiba, 2008). As Fetter (2009a) notes, "nursing programs have embraced distance learning and added informatics content, courses, and specific technologies; however, undergraduates students' and educators' skills are still considered inadequate" (p. 78). Fetter identifies several barriers contributing to this situation, the greatest being those related to wide variations in access to informatics and technologies in clinical agencies and inconsistent integration of informatics content into theory and clinical courses. In addition, the lack of consultation and collaboration between education and service providers often results in a mismatch between competencies required for employment and outcomes of education programs (Fetter, 2009a). Another key barrier to embracing informatics in BScN education is the lack of faculty knowledge, skills, and motivation to integrate informatics competencies into the curriculum (Curry, 2010; Thompson & Skiba, 2008). In a US national survey of nursing education programs, Thompson and Skiba (2008) found that faculty members considered online course work the same thing as informatics. With regard to faculty members' competence in informatics, 37% rated themselves as "competent" and 26% as "advanced beginners." The majority (82%) indicated that they were self-taught. In several instances faculty members equated being involved in distance learning, online learning, and Web-based instruction as being informatics-prepared. Nagle and Clarke (2004) report similar findings from a national survey of Canadian nursing schools. Less than 25% of faculty members surveyed integrated common software skills into their teaching and approximately 33% rated themselves as having little or no knowledge of the five areas of NI

educational requirements. Although faculty generally agreed that NI and ICT competencies are essential components of nursing practice, some still questioned the relevance of ICT for quality patient care. Furthermore, faculty felt that they had poor access to research databases, clinical information systems, and NI instructional development courses and stated that ICT systems were underdeveloped in a majority of institutions.

Two recent reviews of the literature on the integration of informatics into BScN education highlight additional shortcomings. Gracie (2011) examined literature in the period 2007 to 2011, with a specific focus on studies within the US baccalaureate nursing student population, and found 24 articles, with only four meeting the criteria of the review (conference proceedings were excluded from the review). The author reports inconsistencies in definitions of NI among academic settings and inadequate computer and informatics skills for today's health-care environment. De Gagne, Bisanar, Makowski, and Neuman (2011) evaluated the literature on informatics integration in BScN education from 2000 to 2010. The search yielded 59 articles, with 25 fully reviewed and 19 selected for inclusion. The authors report a lack of consensus on informatics concepts that should be included in BScN curriculum, concepts that should be considered a prerequisite to BScN education, and content that should be specifically covered in the program. Although these two reviews point to significant concerns and challenges in current informatics education at the BScN level, the issues identified are no different from those noted by Staggers and her team over a decade ago (Staggers et al., 2001). This begs the question, What has been achieved thus far in terms of enhancing capacity in informatics among future nurses?

Methods

We used a systematic review methodology guided by the research question *What methods/strategies and outcomes are associated with integration of informatics in BScN education?* The search criteria were limited to English-language articles published in CINAHL Plus with Full Text, Academic Search Complete, ERIC, Medline, and Science Direct from 1990 to 2011. The search terms were *computer literacy, information literacy, nursing informatics, health informatics, education, baccalaureate nursing students, integration in curriculum,* and *educational interventions.* Additional articles were included based on a review of the reference lists published in key peer-reviewed journals. Publications that reported on non-BScN students or nurses already in practice were excluded. All results were uploaded to a RefWorks account and duplicates were removed.

The authors reviewed the selected studies independently. For articles reporting on research studies, the data abstracted included author(s), year of publication, study design, type of educational strategy/method used, sample and response rate, outcomes examined, findings, and recommendations made by the authors. Only key recommendations were abstracted from publications classified as discussion reports. The authors checked one another's work for a random sample of 10 articles and found that they abstracted the same information for all of these articles with no discrepancies. Synthesis of study findings and statistical results could not be performed due to the heterogeneity of studies included in our review; therefore, the results will be reported using a narrative approach.
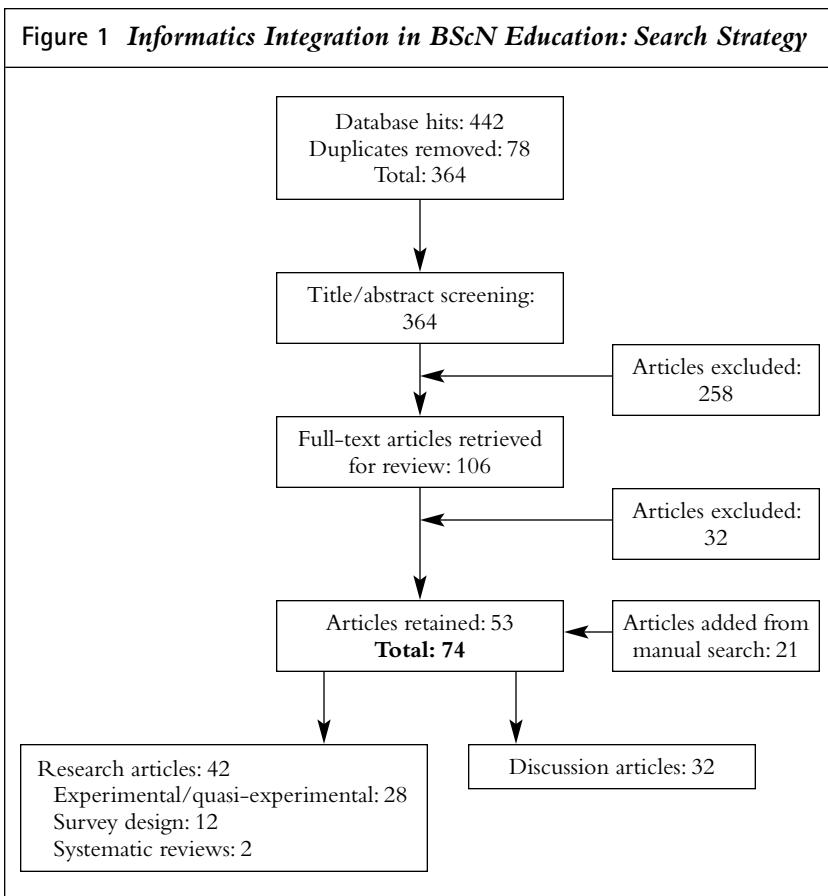
Results

Literature searches yielded 442 articles (Figure 1). After removal of duplicates and screening of titles, abstracts, and full-text articles for relevancy, 53 articles discussed the topic under review. An additional 21 articles were included following a manual search of the reference lists of peer-reviewed articles. For organizational purposes, we grouped the results into two categories: discussion articles ($n = 32$) and research articles ($n = 42$). Research articles were further classified by study design. In this review we focus on recent publications, with the exception of a few older articles that support key themes identified in relation to NI education. Access to all abstracted articles is available by contacting the authors.

Themes in Discussion Articles on Informatics Education in Nursing

The importance of informatics education among nursing students was a central theme in all articles. Skiba (2011) warns against a quick-fix approach to integrating informatics and calls for integrating informatics into all aspects of the curriculum. Building capacity in informatics among future nurses is a complex and multifaceted process requiring collective efforts. Initiatives such as TIGER and HITS effectively embed informatics across the curriculum using various strategies to enhance informatics competencies among both nursing faculty and nursing students and therefore should be promoted (Connors, Warren, & Weaver, 2007; Weaver & Skiba, 2006). Faculty buy-in and informatics preparedness facilitates the development of informatics competencies among nursing students; therefore, supporting faculty members in this process is key for accelerating development of competence among future nurses (Curry, 2010; Taylor, Hudson, Vazzano, Naumann, & Neal, 2010).

A number of strategies are recommended for enhancing readiness in informatics, including simulation (Donahue & Thiede, 2008; Linder & Pulsipher, 2008), PDAs (Martin, 2007), and online learning tools (Skiba,

Figure 1 *Informatics Integration in BScN Education: Search Strategy*

Database hits: 442
Duplicates removed: 78
Total: 364

Title/abstract screening: 364

Articles excluded: 258

Full-text articles retrieved for review: 106

Articles excluded: 32

Articles retained: 53
Total: 74

Articles added from manual search: 21

Research articles: 42
  Experimental/quasi-experimental: 28
  Survey design: 12
  Systematic reviews: 2

Discussion articles: 32

Connors, & Jeffries, 2008). Access to health-care technology and experience with hospital information systems are identified as necessary for having students and nursing faculty relate to technology in the context of care (Borycki, Kushniruk, Armstrong, Joe, & Otto, 2010). Collaboration between service and academia as well as between faculty members and librarians is noted as important for facilitating informatics education (Melo & Hodson-Carlton, 2008; Schulte, 2008). Given the availability of research-based lists of competencies in informatics, some authors cite the importance of embracing these lists to help guide the integration of informatics in the nursing curriculum (Gassert, 2008). Fetter (2009c) outlines several challenges facing educational institutions, such as the lack of an appropriate informatics infrastructure to support student learning and collaboration between service and academia.

Themes in Research Studies on Informatics Education in Nursing

Findings from the research articles included in this review show a variety of methods and approaches currently being used to incorporate informatics into BScN education. Some programs offer NI as an elective course (Marini, 2000) and some offer assignments (Jacobsen & Andenaes, 2011). Few studies report on a systematic threading of informatics content across the nursing program (Desjardins, Cook, Jenkins, & Bakken, 2005; Travis & Brennan, 1998). Some programs provide laboratory learning experiences (Donahue & Thiede, 2008) and others a combination of theory and clinical application (Desjardins et al., 2005; Travis & Brennan, 1998). Some offer a theory component alone (Kenny, 2002). Content focuses mostly on skills related to computer and information literacy (Jacobsen & Andenaes, 2011; Marini, 2000). Few studies report on teaching core content in HCI and NI (Desjardins et al., 2005; Kenny, 2002; Travis & Brennan, 1998).

A variety of pedagogical strategies are currently being used in the delivery of informatics education. Some programs use simulation technology to provide hands-on experience in hospital information systems (Jones & Donelle, 2011; Lucas, 2010). The utility of mobile technology such as PDAs as a learning tool in clinical education is examined in a number of studies (Goldsworthy, Lawrence, & Goodman, 2006; Kuiper, 2010). Kenny (2002) reports on use of online learning to teach informatics content at the undergraduate level.

Outcomes associated with informatics education include attitudes, self-efficacy, gain score before and after an intervention, satisfaction with technology, and learning experiences. Evaluations of these outcomes are conducted using quasi-experimental/observational designs. Only one study used an experiment design (Goldsworthy et al., 2006). There are no follow-up studies examining the value of informatics education after graduates have joined the workforce.

A number of studies use a survey design to assess outcomes related to informatics competence. Most of these focus on outcomes related to computer and information literacy skills (Deltsidou, Gesouli-Voltyraki, Mastrogiannis, & Noula, 2010; Elder & Koehn, 2009; Jacobsen & Andenaes, 2011; Nayda & Rankin, 2009). Their findings show that computer and information literacy is relatively poor among nursing students (Deltsidou et al., 2010; Nayda & Rankin, 2009), with a tendency for students to overrate their computer skills (Elder & Koehn, 2009). Edirippulige, Smith, Beattie, Davies, and Wootton (2008) point out that self-reported mastery of computer skills is not an accurate indicator of the level of informatics competence required to safely use e-health applications. Other outcomes examined in these survey studies include self-

reported perceptions of and attitudes towards e-health (Edirippulige et al., 2008). Students' perceptions of and confidence in using ICT are identified as important predictors of use of ICT applications in clinical practice (Levett-Jones et al., 2009); however, nursing students' understanding of the relevance of ICT to clinical practice and their confidence in using these applications are hindered by lack of access and training in the hospital information systems being used in practice settings (Fetter, 2009b; Jetté, Tribble, Gagnon, & Mathieu, 2010; Levett-Jones et al., 2009). Moreover, students in rural settings tend to have less preparedness in information technology than their urban counterparts (Caison, Bulman, Pai, & Neville, 2008).

Discussion

Results from this review show the limited number of research studies reporting on integration of informatics at the BScN level. They also point to a number of variations in informatics education related to core informatics content being offered, type of learning experiences offered, and the approaches used for evaluation/assessment of learning or outcomes of education.

Theory and Clinical Informatics Content Being Offered

Competence is a major determinant of performance, encompassing knowledge, skills, attitudes, and traits (Kak, Burkhalter, & Cooper, 2001). Because education is one route to the acquisition of competence in a particular domain, it follows that curricula must address all aspects of informatics. According to Hwang and Park (2011), both basic computer skills and formal informatics education are strongly associated with informatics competence. Interestingly, most of the educational efforts reported in the literature are geared towards computer competency and information literacy. Theoretical core content on informatics is very limited at the undergraduate level. These findings are consistent with those of previous reviews on the topic (De Gagne et al., 2011; Gracie, 2011). While we agree that computer skills and information literacy are important for interacting with technology, we stress that these must be directly applied to patient care so that undergraduates learn to meaningfully use information technology applications in the clinical context (Jetté et al., 2010; Levett-Jones et al., 2009). A helpful strategy for nursing educators involved in the design of informatics instruction is to use the informatics competency lists available in the recent literature, as these detail aspects of expected competence for nursing graduates (Gassert, 2008). Clinical exposure and experience with clinical information systems are critical for

demonstrating to students how these applications work and how they affect patient care. Without such exposure, graduates' ability to manage day-to-day practice and safely use these applications may be compromised. In a survey of baccalaureate nursing graduates, respondents gave their lowest competence rating to "care documentation, planning, valuing informatics knowledge, skills development, and data entry competencies" (Fetter, 2009b, p. 86). Interestingly, these are some of the key skills that employers expect new graduates to possess upon entry to practice (McCannon & O'Neal, 2003). Graduates entering the workforce with perceived low levels of informatics competence learn by trial and error during the transition to practice and may become too focused on the technology to grasp the broad scope of informatics in the context of patient care. In order to enhance future nurses' competence and confidence in using health-care technology, nurse educators could, in collaboration with service providers, develop hands-on training in the informatics systems currently being used in health-care facilities (Jetté et al., 2010). Such learning experiences could help students develop their thinking and their decision-making in using technology in health care, both of which are highly desired outcomes of education for effective integration in current complex work environments (Candela, Dalley, & Benzel-Lindley, 2006).

Methods and Strategies for Teaching Informatics

In terms of pedagogical strategies, the increased use of simulation technology related to hospital information systems is encouraging. Students participating in these projects found that hands-on experiences with simulated hospital information systems boosted their confidence and eased their transition to clinical roles (Borycki et al., 2010; Lucas, 2010). Also encouraging is the increased use of mobile technology such as PDAs at the undergraduate level. PDAs facilitate learning through access to patient-related information or evidence-based resources in the clinical setting (Goldsworthy et al., 2006; Kuiper, 2010; Newman & Howse, 2007). In addition, PDA use improves students' confidence regarding computer ability, computer self-efficacy, and clinical reasoning skills (Kuiper, 2010). Studies have found significant associations between satisfaction with PDA use for learning and attitudes towards computerized documentation (Newman & Howse, 2007).

Surprisingly, few programs use online technologies to teach informatics at the undergraduate level (Kenny, 2002). In terms of efficacy, when compared to face-to-face instruction, online learning is equally effective and in some instances leads to better outcomes (Bloomfield, Roberts, & While, 2010; McMullan, Jones, & Lea, 2011). Online education as a

means for training nurses in informatics could facilitate the delivery of informatics education to a large number of students as well as help streamline faculty resources, thus addressing limitations related to the shortage of qualified faculty members with NI or HCI expertise (Gassert, 2008).

Evaluation/Assessment of Learning Outcomes

A wide range of variables, such as knowledge gain, self-efficacy, confidence, attitudes, perceptions, experiences, satisfaction, and motivation, have been examined in research studies on informatics educational interventions among BScN students. These are all relevant outcomes for NI research, as they influence behaviour and performance and hence competence development (Kak et al., 2001). The majority of the studies included in this review, however, examine these outcomes in relation to some aspect of informatics — that is, computer literacy, basic computer skills, or information literacy — as opposed to comprehensively evaluating informatics competency. Few authors demonstrate links to clinical practice through the use of PDAs and simulated hospital information systems as tools for educating nursing students in informatics. In addition, the assessment of informatics competence focuses largely on self-reported assessment, without accounting for factors that could have contributed to the outcome.

Evidence on the Effectiveness of Informatics Education

Evidence on the effectiveness of informatics education at the BScN level remains unclear. First, research on informatics education at the BScN level is relatively recent, with most studies being small in scale and mainly descriptive and/or quasi-experimental. Such designs do not allow for much control over possible known and unknown confounders that could contaminate the intervention effect (Shadish, Cook, & Campbell, 2002). In addition, rigour becomes even more difficult to achieve when tools used for measuring outcomes do not adhere to appropriate psychometric principles to ensure validity and reliability (Staggers et al., 2001). Second, issues related to sample size and the heterogeneity of outcomes measured in such a limited number of studies preclude synthesis of evidence generated to date. Future research should consider rigorous research methodology with a focus on evaluation, to better capture the impact and value of informatics education in both the short and the long term. In addition, mixed-method studies could be used to generate evidence on the effectiveness of informatics education from multiple perspectives. Lastly, we need follow-up studies on the effectiveness of informatics education in the work life of graduates.

Implications and Suggestions for Improving Educational Outcomes in Informatics

Educational institutions, service providers, and nurse educators play an important role in shaping the learning experiences of nursing students in informatics. Educational institutions need to make a clear commitment to informatics education at the undergraduate level by identifying informatics competencies in their program outcomes. In 2010, entry-to-practice competencies related to information collection, management, and use were introduced in the Canadian Registered Nurse Examination (Nagle, Hannah, & Hammell, 2011). The incorporation of NI content in licensing examinations may encourage undergraduate nursing programs to embrace NI in their curricula.

Nursing educators need to consider multifaceted strategies when designing informatics education in order to obtain the desired change in all outcomes related to competency development. As Fetter (2009c) notes, a variety of strategies and the intensive use of technology throughout curricula would be most effective for improving students' informatics competencies. An example of such a multifaceted intervention is noted in the work of Travis and Brennan (1998) at Case Western Reserve University. A sequential method was adopted to integrate theoretical and relevant clinical experiences into the undergraduate curriculum using the framework of technology, information, and clinical care processes. This approach to integration allowed for levelling informatics education according to the level of education in the program — that is, computer and information focuses were offered in the first 2 years of the program and more advanced skills and clinical experiences in the second 2 years. Integration of theoretical knowledge and clinical experiences related to informatics education enhances students' ability to understand how informatics relates to nursing and to patient care (Fetter, 2009a, 2009c; Staggers et al., 2001). Educational interventions that are pedagogically informed and systematically designed have an increased likelihood of achieving the desired outcomes (Kaakinen & Arwood, 2009). Selected resources that may be helpful are listed in Appendix 1.

Lastly, policy-makers in institutions of higher learning and in service sectors should create more opportunities for collaboration, to support and facilitate development of informatics competencies among nursing students (Gassert, 2008). With the systematic integration of informatics theory and practice applications, and the use of a variety of pedagogical strategies in the delivery of informatics instruction during basic nursing education, nursing students will develop confidence and competence in using health-care technology within the security of the educational setting prior to entering the work environment.

Conclusion

Our review of the literature on integration of informatics in BScN education reveals wide variations in methods and strategies. These variations impact educational outcomes in relation to informatics and consequently the level of competence expected from graduates of BScN programs. First, variations exist in the core content of informatics, with a tendency to focus on computer and information literacy without effectively linking these skills to nursing practice. Nursing programs need to consider the distinct differences between such concepts and develop content that reflects the practical application of ICT in the context of care and nursing practice. Second, there is inconsistent integration of theoretical knowledge and clinical experiences related to informatics education as well as variations in the duration and sequencing of informatics instruction. Informatics education should be tailored to address both aspects of theory and clinical applications in health information technology, with appropriate sequencing throughout the nursing program. Third, variations exist in relation to teaching strategies used for integrating relevant informatics content in the curriculum, especially the limited use of online learning modalities to facilitate delivery of informatics education at the undergraduate level. Online learning offers an array of possibilities and could help accelerate the process of building competence among BScN students. Fourth, the effectiveness of informatics education at the BScN level remains unclear given the limited number of studies undertaken, the quality of evidence generated to date, and the lack of follow-up studies. Careful planning and evaluation of informatics education interventions would help ensure effective and efficient use of resources and a realistic view of the level of informatics competence among BScN students. This should be followed by evaluation studies that systematically assess the status of informatics competency among future graduates.

Appendix 1	*Recommended Resources to Guide Nursing Educators in Developing Informatics Education*

The Nurse Educator eHealth Resource, published in 2012: http://rnao.ca/sites/rnao-ca/files/RNAO.NurseEducator.eHealth_-_Draft_2_-_10252012.pdf

The CASN Nursing Informatics Inventory: A Report of Existing Teaching and Learning Resources, published in 2012: http://www.casn.ca/vm/newvisual/attachments/856/Media/20122CASNNIInventorywithCompetenciesFINALwcover.pdf

The Essentials of Baccalaureate Nursing Education: www.aacn.nche.edu/education-resources/baccessentials08.pdf

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