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Building the Clinical Bridge to Support Nursing Effectiveness Science

Guest Editors: Kathleen Potempa, John Daly, and Marita G. Titler

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Editorial Board

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Editorial

Building the Clinical Bridge to Support Nursing Effectiveness Science

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1. Background

Several forces in the US, including the need to control rising health care costs, are converging to require quality and safety outcomes as a factor in reimbursement for health care services. Many of the established outcomes, including nosocomial decubitus ulcers, falls with injury, medication errors, and self-care management are quality indicators sensitive to nursing care. Requirements for transparency in reporting outcomes as well as the rapid expansion of electronic health records (EHRs) are producing opportunities to study clinical care processes and outcomes as heretofore not possible. The ability of nurse researchers to define the database structures of EHRs, access these data and set forth analyses for health systems to improve care is a compelling reason to build solid relationships between academic and health care institutions. But perhaps more compelling is the opportunity to fully advance the professionalization of nursing through the unification of missions, ultimately for the betterment of patient care and the improved education of new generations of nurses.

Other professions, especially physicians, have long experienced the benefits of uniting their tripartite missions of patient care, education, and research. They have utilized the "power" of the Academic Medical Center to fuel discovery, innovation and the rapid translation to clinical care. Medical students and postgraduate trainees benefit from this environment; their mentors are faculty with significant research programs, attending physicians responsible for patient care, leaders within the health system administrative structures driving policy, and teachers of the next generation. The opportunity of a unification model of varying types, to advance professionalization and influence of nursing in care decisions, policy, and the discovery and translation of knowledge to care practices is essential for us to leverage this "new age" where much is expected of nurses and nursing in the evolution of health care within countries and in the US, health care reform.

The future of nursing requires that we employ a unified approach in research, education, and practice. Consequently, there is an imperative (1) for nurses to practice to the fullest extent of their education and training; (2) to improve educational systems that offer seamless progression to higher levels of education; (3) for nurses to be full partners with physicians and other healthcare professionals to transform healthcare delivery; and (4) to meet work force demands for nurses globally [1].

1.1. Effectiveness Science. One of the emerging sciences that will benefit from a unified academic-practice environment is "effectiveness science." Effectiveness science, essential to improving quality and cost of healthcare, includes testing health care interventions in real world settings, advancing use of research findings by diverse populations, and training and career development for the next generation of investigators in the field. Effectiveness science uses comparisons, subgroups, and context to determine what health care treatments work for whom and in what setting. This includes comparisons of treatments as well as models of care delivery [2].

Effectiveness science is receiving increasing attention in healthcare [3]. The purpose of effectiveness research is to help consumers, clinicians, purchasers, and policy makers to make informed decisions that will improve health care at the individual and population level [4]. Findings from effectiveness research are designed to strengthen health care systems by ensuring that care delivered is based on the best possible evidence and informed decisions.

Nurses are optimally positioned to address many defined priorities in effectiveness science. These research priorities include testing the effectiveness of (1) primary prevention methods in preventing falls in older adults at varying degrees of risk; (2) dissemination and translation strategies to promote use of research findings by patients, clinicians, payers, and others; (3) strategies for reducing healthcare associated infections; (4) comprehensive care coordination programs in managing children and adults with chronic illness, especially in populations with known health disparities; (5) school based interventions involving meal programs, vending machines, and physical education, at different levels of intensity, in preventing and treating overweight and obesity in children and adolescents; and (6) various strategies (e.g., clinical interventions, social interventions) to prevent obesity, hypertension, diabetes, and heart disease in at-risk populations such as the urban poor and Native Americans/American Indians [4]. Nurse scientists have built and will continue to build programs of research in these and other important areas of need and must interface with the larger national and international effectiveness agenda to inform priorities for effectiveness science, and garner funds for their research. Additionally, nurse scientists have methodological expertise essential to move forward this national and international agenda; these include meta-analysis, research synthesis, large dataset analysis, and experimental and observational research methods.

Our professional contributions to effectiveness science can best be achieved through unification models of education, practice, and research in which practice issues inform the effectiveness research agenda, researchers test interventions in real world settings, and practitioners, learners, and investigators can simultaneously understand why some healthcare interventions work in some settings, and with some populations, but not others. This deeper understanding of the mechanisms to improve health, patient outcomes, and healthcare systems will benefit consumers, payers, and public policy stakeholders. If we are to meet the healthcare challenges of today and into the future, our profession can no longer afford to isolate practice clinicians, educators and scientists and treat learners as guests in practice settings during their educational experience. We must unify to promote clinical inquiry, maximize the impact of research, promote excellence in patient care, and build a professional culture of life-long learning.

2. Overview of Papers

In this special edition, you will find papers related to different "views and levels" of the "clinical bridge," processes to consider in building the bridge, some preliminary outcomes of unification in sample environments, as well as specific examples of the research that the faculty immersed in clinical environments can generate with application to clinical care.

2.1. Process of Partnership and Emerging Outcomes. Three papers focus on processes and outcomes of building the clinical bridge between academia and practice. The integrative review by J. A. Beal describes what is empirically known about academic-service partnerships in nursing. Analysis of publications revealed that empirical knowledge about academic-service partnerships is in the areas of prerequisites for successful partnerships, types and benefits of partnerships, and workforce development with themes of academic-practice progression and educational redesign. Most publications about academic service partnerships were descriptive in nature but did not include formal evaluation of outcomes. Future empirical work in this area should address the effectiveness of these partnerships using rigorous evaluation methods.

Development of a robust clinical bridge in Australia, through jointly funded positions at the professorial level, is described by M. Wallis and W. Chaboyert. The evolution of this unique model of building a clinical bridge and expanding to several practice environments provides an exemplar for others interested in creating partnerships between practice and academia. The impact on research productivity, dissemination of research findings, and changes in practice are described.

The paper by M. Svjeda and colleagues describe the process and outcomes of a partnership between the University of Michigan School of Nursing (UMSN) and nursing services at the University of Michigan Health System (UMHS) entitled "the Initiative for Excellence in Clinical Education, Scholarship and Practice." The partnership is designed to leverage the resources and expertise of both organizations to advance the three missions of education, research, and practice. The whole-scale change process was used to bring faculty and practice stakeholders together for this initiative. An innovative model of clinical education was developed, piloted, and is now fully implemented in the undergraduate curriculum. Key findings of this model are provided. This paper addresses the processes, lessons learned, and successes of using an innovative method of education through building a clinical bridge between academia and practice.

Collectively, these 3 papers point out the importance of evaluating these innovative academic-practice partnerships and lessons learned from these experiences. These exemplars are helpful to guide others interested in addressing the building of clinical bridges between academia and practice to maximize student learning, improving quality of care, and improving outcomes of learners.

2.2. Context Issues and Effectiveness Science. Two studies focus on context factors in effectiveness science. In an effort to understand communication among clinicians, a key variable that impacts patient outcomes, D. Tschannen and E. Lee explored the impact of nursing characteristics

(e.g., job category, education, experience, and expertise) on perceptions of communication in the acute care setting. Specifically, the more positive the environmental values (e.g., high trust, respect), the greater the perception of communication openness among nurses. They also found that nurses' experience was significantly related to openness of communication among nurses and physicians. Work environments that foster trust, respect, status equity, and time availability create an atmosphere where communication can flourish.

D. Wilson and colleagues compared the perceptions of nursing units' safety culture between charge nurses and staff nurses. The charge nurse was defined as a frontline nursing unit leader who makes shift-by-shift decisions about staffing, personnel, and unexpected events that impact patient care. They found that nurses with no charge experience had more positive overall perceptions of patient safety as compared to those with some charge experience. Charge nurses with one or more years of experience were less positive about teamwork, overall perceptions of safety, and number of safety events reported. These two papers draw attention to the importance of factors in the clinical environment, such as trust and characteristics of clinicians, that should be considered in conducting effectiveness science.

2.3. Interventions and Technologies. Two papers address the effectiveness of interventions and technologies. L. L. Shever and M. G. Titler examined factors that contribute to adverse incidents of hospitalized older adults, using a model that included patient characteristics, clinical conditions, nursing unit context of care variables, medical treatments, pharmaceutical treatments, and nursing treatments. This exploratory observational study used data from electronic health records as well as other electronic repositories and demonstrated that the type of nursing treatments associated with adverse incidents were diverse. This study illustrates the importance of partnering between academic and practice sites that have electronic data to address nursing effectiveness research questions.

P. A. Abbott addresses the challenges and opportunities in effective use of technology. This study evaluated how a specific technology (mobile clinical computing appliance consolidating numerous technological functions), designed to address technology crowding, is used in the real-world environment. Studies that compare how health IT is *actually used*, versus how the device was *designed to be used*, are necessary. This paper is a useful illustration of examining effectiveness of technology to assure usability and patient safety.

2.4. Knowledge Application and Education. Three papers address innovations in knowledge application and education. A. Pearson and colleagues describe the nature of evidence-based healthcare and translation science, propose a reconceptualization that brings together these two conceptual areas, and asserts the existence of a third fundamental gap that is rarely addressed: the gap between knowledge need and discovery. They argue that if the evidence-based health care movement is to progress and make any real impact on health outcomes, it is imperative that the nature and processes of these two enterprises are integrated.

M. Aebersold and colleagues evaluate the effectiveness of virtual reality simulation, using two virtual simulation scenarios, to improve undergraduate student's performance regarding interpersonal skills (e.g., communication, professional behavior). The use of second life and creation of a virtual inpatient unit are among the innovative interventions used in this educational approach. Virtual world simulation environments offer a unique and potentially cost-effective method of teaching leadership and management skills.

Moss and colleagues describe an innovative nursing research training model, the HOMInG Device, for doctoral education. This model and approach to research training focuses students on the interrelationships among four domains of their research enterprise—the substantive research topic, their interests as researchers, the research context, and particular research approach. Working with this model means that students engage consistently with these inter-relationships: from initial ideas and planning, to dissemination and positioning of the newly generated knowledge within clinical practice. Evaluative data suggest that this model facilitates doctoral education and research training.

In summary, papers in this special issue are a source for generating greater understanding of how to proceed and what to expect along the path of development in building partnerships between academia and practice. The importance of such unified models provides benefits for effectiveness science, and application of innovative approaches to research, education, and practice. It should be noted that while these papers refer to work in hospital settings, the benefits of unification transcend specific environments and can and should benefit communities and populations with appropriate organizational partners.

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Review Article

Building the Clinical Bridge: An Australian Success

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Nursing effectiveness science includes primary, secondary, and translational, clinically focused research activities which aim to improve patient or client outcomes. It is imperative, for the successful conduct of a program of nursing effectiveness science, that a clinical bridge is established between academic and healthcare service facilities. An Australian example of the development of a robust clinical bridge through the use of jointly funded positions at the professorial level is outlined. In addition, an analysis of the practical application of Lewin's model of change management and the contribution of both servant and transformational leadership styles to the bridge building process is provided.

1. Introduction

In Australia, a relatively popular strategy, aimed at improving collaboration between clinicians and research focused academics, has been the appointment of a Professor of Nursing and/or Midwifery into a Clinical Chair position, jointly funded by a university and a health service or hospital (a joint Clinical Chair). There has been much commentary, especially in Australia, about the development of such positions [1–4]. What is not so clear from this commentary is what elements surrounding this strategy lead to successful collaborative partnerships and the development of a clinical bridge to enable nursing effectiveness science.

By nursing effectiveness science we mean primary, secondary, and translational, clinically focused research activities which aim to improve patient or client outcomes. Activities involved in nursing effectiveness science include systematic reviews and meta-analyses of previously conducted research studies, exploratory, correlational, and experimental clinical research studies, and translational research studies aimed at changing clinical practice. In this paper we outline the antecedents that shaped one university-health service collaboration and the change management strategies which helped construct the clinical bridge. We also explore how different types of leadership facilitated the achievement of outcomes, and finally we comment on future directions for nursing effectiveness science.

2. The Context

Joint Clinical Chair positions in nursing emerged, in Australia, in the late 1980s. By 1996 there were 20 joint Clinical Chairs in Australia [5] and currently there are many more. Generally, these positions are appointed at the level of Professor although some have been appointed at the level of Associate Professor. There is also a distinction between "generic" joint Clinical Chairs (i.e., Professor of Nursing, Professor of Midwifery or Professor of Clinical Nursing Research) and "specialist" joint Clinical Chairs (i.e., Professor of Critical Care Nursing). In the early days, the focus, goals, and structures associated with these positions were largely driven by individuals. At a two-day symposium, in Sydney, in the late 1990s, a number of incumbents and stakeholders described the positions that were then in place and it was clear that there was no coherent model for what the joint Clinical Chairs would do, whether the focus should be broad or narrow and how they would work across academic and service organisations (personal communication, M. Wallis 2011). Qualitative research into the perspectives of a number of the early incumbents of

these positions confirmed that there was a "diversity of arrangements between university and health sector partners in establishing their respective roles" [2, page 165].

The main challenge that was identified early in the development of these positions was the potential for unrealistic workloads [1]. As Darbyshire [4] expressed it.

> *Not only will the professor be expected to be a top researcher, winning grants, establishing research programmes, publishing, supervising, teaching, leading, consulting, examining, networking, presenting and more, but in the service sector they will also be expected to be a kind of super staff development guru and contract researcher whose role is no less than to change the nursing culture of the organization, improve care and service provision quality and give the "research answers" that will extinguish the most troublesome clinical, professional or organizational fires of the day. "After all", you can hear the hospital executive thinking, "we pay half of their salary, so we may as well use them." (p. 2595).*

This quote also alludes to the fact that universities and health service providers may not only have quite disparate cultures, they may also have dissimilar goals and expected outcomes. Despite these problems, there continues to be university and healthcare organisational commitment to these positions. In 2000, the Faculty of Nursing, at Griffith University, in southeast Queensland, Australia, and the Division of Nursing in one of the local healthcare services, Gold Coast Health Service District, appointed a joint Chair, Clinical Nursing Research.

3. The Beginning of the Clinical Bridge

If a clinical bridge is to be built to support nursing effectiveness science, the first things that have to be in place are senior people with vision and the resources to support that vision [3, 4, 6]. On the Gold Coast, in Queensland, Australia, in 1997, the two people with vision were the Dean of the Faculty of Nursing, at Griffith University, and the Executive Director of Nursing (EDON) of the local health service. These two transformational leaders [7] had a mutual respect for the contribution of healthcare services and academic institutions to professional nursing and to client outcomes. While the role of the EDON necessarily focused on service delivery, there was a clear understanding of the value of a collaborative approach to healthcare that incorporated research and education. The Dean was clear about the critical importance of clinical practice to the discipline and the need for clinically informed and clinically relevant research. Together, because of their perspectives, they developed a plan to address the theory-practice gap that was evident in Australia at the time [8].

The plan that was developed, and eventually endorsed by senior management in both organisations, was to appoint a joint Clinical Chair. The Dean and EDON had carefully considered what was required within the local context and had decided that this needed to be a transitional position. The joint Clinical Chair was not designed to last forever and the need for change and evolution of the role were incorporated from the beginning. It would have a generic focus (i.e., nursing) but would specifically include in the title the word "research" to signal to all parties the main focus of the position. A contract was drawn up for a joint Chair, Clinical Nursing Research, and appropriate resources were allocated not just to the funding of the position, but also to research nurse support at the clinical site. The incumbent was to be employed by the University, but half the salary was paid by the health service. Office space was provided within both organisations although more time was to be spent on site at the hospital.

Based on their assessment of the clinical context, the Dean and EDON decided that the first step was to appoint a leader who could drive the development of the people, the infrastructure and the capacity required to build an ongoing program of clinical nursing research. This position was always seen by all parties as the beginning of a collaboration that would be focused on building a clinical research culture within the health service and on developing then the Faculty of Nursing (now School of Nursing and Midwifery) into a leading nursing research facility. As such, the second vitally important element to the successful development of the joint Clinical Chair was clarity and unity related to the anticipated outcomes for the position [3]. The Dean and the EDON were both broadly in agreement that the goals for the position were to increase research funding from external, competitive funding bodies, increase peer-reviewed publications, and increase the number of Ph.D. completions; and they allowed the first incumbent to negotiate the key performance indicators and the timelines.

4. Build It and They Will Come

When building the clinical bridge to facilitate effectiveness science on the Gold Coast, an approach was taken that integrated Lewin's [9] model of unfreezing, moving, and refreezing with leadership approaches that included both servant leadership [10] and transformational leadership [11]. Figure 1 depicts the cyclical nature of the bridge building process, outlines some of the key elements, and indicates leadership approaches that can bring success.

In 2000, when the joint Chair, Clinical Nursing Research, was appointed, a sense of urgency and excitement was palpable within both organisations. As Kotter [12] suggests establishing this sense of excitement is important as it motivates people to get outside their comfort zones and contributes to Lewin's unfreezing phase. Local and regional promotion of the new position built on this excitement and an initial process of meeting and discussing potential collaborative endeavours provided the opportunity for the incumbent to commence the position with a servant leader focus. Servant leadership is as much about followership as it is about leadership. Servant leaders begin by discovering the needs of the people they serve [10]. They give priority to their relationships with followers rather than their relationship with the organization and emphasise followers' holistic

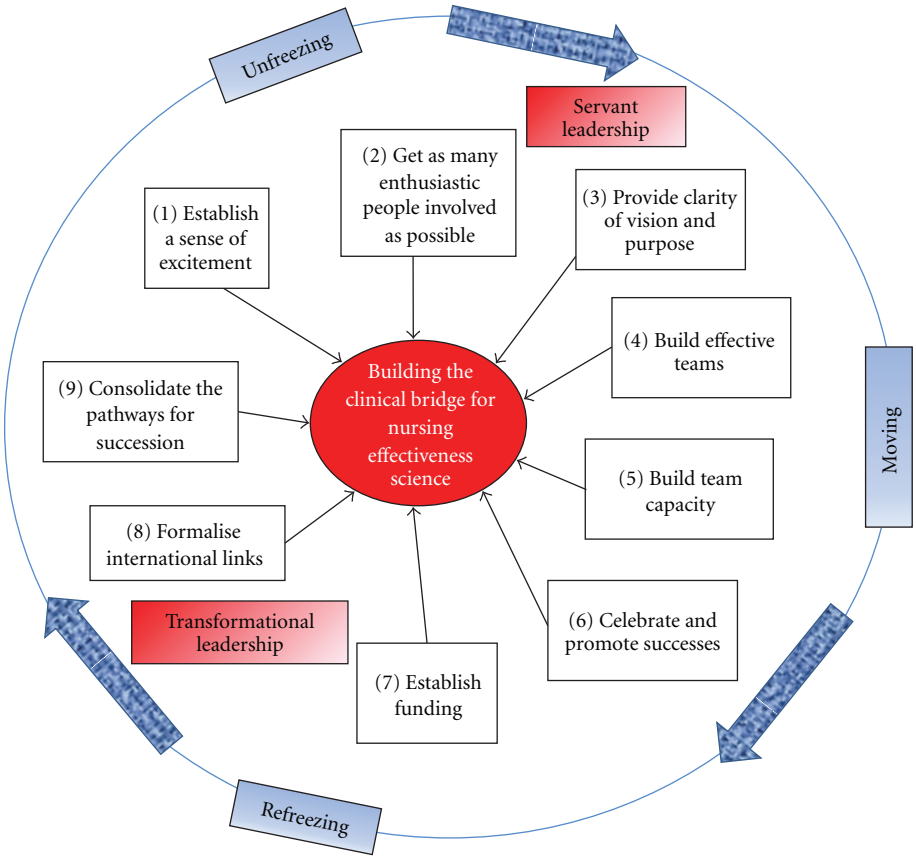

Figure 1: The cycle of organisational change management involved in building a clinical bridge for nursing effectiveness science.

needs, development, and autonomy [13]. Servant leaders exercise their influence through the transformation of their followers. In contrast, transformational leaders focus on mobilizing followers to achieve "performance beyond expectations," which is the ultimate priority of the organisation [7].

If any leadership position is to function effectively, there also have to be willing followers and collaborators [14]. Both organisations had enthusiastic academics and clinicians who had already begun to establish links around specialist clinical education and clinical research projects. One of the things that made the bridge easier was the movement of specialty postgraduate nursing education from the hospital setting to the university which occurred a few years prior to the establishment of the joint Clinical Chair. As another element in the unfreezing of the clinical and academic environments (see Figure 1), specialist Master-of-Nursing programs (e.g., Critical Care Nursing, Emergency Nursing, etc.) were offered in a university-hospital partnership model. Consequently, university academics and hospital-based clinical educators had established excellent working relationships. Also because the courses were at the Master-of-Nursing level, the students (many of whom were clinical leaders) received some research training, increasing their appreciation of the value of clinical research. In addition, one Ph.D. prepared academic was already working with a clinical manager, a clinical specialist, and an educator and building a strong track record of research around ICU nursing.

Despite this ground work, in 2000 the Gold Coast Health Service District was not a research-ready, let alone a research intensive, healthcare facility; it was primarily focused on service provision for members of the local community. The Faculty of Nursing at Griffith University was similarly just beginning its development as a centre for clinical research. There were many researchers beginning their careers, but there was little focus and no critical mass of researchers who were working together either in the University or the Health District. As southeast Queensland became the focus of internal migration within Australia, and the population along the corridor from Gold Coast to Brisbane boomed, it became clear that there would need to be a huge expansion in healthcare services and that this presented a unique opportunity to build a research centre that would not only improve the health of Queenslanders, but also could develop into a centre of international repute.

As discussed by Ba Banutu-Gomez [15, page 147] "the central role of a servant leader is to establish a sustainable strategic vision for the organisation ...." Thus at the end of 2002, as a strategy both to complete the unfreezing stage and then to direct the moving stage of change (see Figure 1), the joint Clinical Chair and other leaders in the nursing faculty, building on their beginning successes in collaborative clinical

Table 1: GCHSD nursing research outputs 1999–2008.

Biennium	Total funding	Conference posters	Conference papers	Peer-reviewed publications
1999-2000	$700	8	3	2
2001-2002	$220,000	1	21	15
2003-2004	$270,000	5	20	24
2005-2006	$643,000	1	27	43
2007-2008	$1,187,255	5	48	45

research, wrote a proposal for a research centre to focus on clinical innovation. The Griffith University Research Centre for Clinical and Community Practice Innovation (RCCCPI) was launched in 2003. While initially RCCCPI was a collaboration between the Griffith University School of Nursing and Midwifery and Gold Coast Health, it expanded quickly and membership now includes researchers in six major teaching hospitals in southeast Queensland and has strong links to universities in Australia, Canada, the UK, and the USA. There were a number of iterations of the programs within the Centre until eventually significant multidisciplinary teams of people coalesced around the areas of acute and critical care; ageing and older people; nutrition; and maternity and family. The leadership of RCCCPI maintained and grew the strong links with the joint Clinical Chair and the growing number of clinicians engaged in research in the health service. More clinicians enrolled in and graduated with research degrees and the joint Clinical Chair and senior research colleagues started to acquire competitive grants.

In order to maintain the momentum and to keep the change process moving, a number of strategies were employed that were designed to build effective teams and to build team capacity (see Figure 1). One of these strategies was to conduct workshops for clinicians related to evidence-based practice. University-based academics as well as the joint Clinical Chair and hospital-based researchers all contributed to these workshops. Funding was sought to allow nurses to attend these workshops in work hours, and an evaluative research study of these workshops clearly indicated positive attitudinal change in clinicians [16]. The health service then had a cohort of senior clinicians who were primed with a critical approach to their practice and ready to "move" into research. Having a joint Research Seminar Series between RCCCPI and the health service meant that research conversations between academic and clinical nurses continued that movement. Other early strategies that worked included setting up a Visiting Nursing and Midwifery Research Fellow Program and setting up a mentorship program for clinicians involved in research. The Visiting Nursing and Midwifery Research Fellows were Griffith University nurse researchers who would come and work in an honorary capacity with clinicians in particular specialist areas. They were appointed in areas such as ICU, community care, mental health nursing, and midwifery and they joined teams of clinical nurses and midwives to help develop programs of research in specialist areas. When in the hospital setting, they were supervised by the joint Clinical Chair.

Funding for research activities, in the early days, was a challenge, as is commonly the case [4]. Establishing a funding stream for research activities is, however, vital if the clinical bridge is to be sustained and the change to a research intensive clinical culture is to be "refrozen." So various strategies were employed including: always having research teams that incorporated academics and clinicians (something that appeals strongly to the organisations that fund clinical research); focusing research activity on areas of high interest to funding bodies; approaching local health service power brokers with clearly articulated proposals for projects of mutual benefit; accepting appointments to strategic committees, at higher levels of government; linking with medical colleagues to establish research positions within the clinical environment; and finally making sure that there were working relationships and strategic alliances at all levels in the health department. Together all these strategies, and the work of a growing number of collaborative groups, began to bear fruit.

5. Growing Success

As a way of both measuring and celebrating the successes of the first few years, the health service produced a Compendium of Nursing Research every second year. Both the health service and the university produced many reports about their total activities, but the Research Compendium served to celebrate, specifically, the successes of teams that involved the clinical nursing staff and served to highlight the strong connections between the two organisations. Table 1 is a reproduction of the table originally published in the 2009 Compendium.

In the early phase of building the clinical bridge, the successes steadily accumulated but it was not until 2005 that significant funding successes began to flow through to research outputs such as publications in international journals. This initial period saw the success of a servant leader approach. The joint Clinical Chair and Visiting Nursing and Midwifery Research Fellows worked closely with clinicians and followed their suggestions for areas of research focus. By weaving this approach with a transformational leadership approach, which involves shifting the values, beliefs, and needs of followers to meet organisational goals through empowering and building capacity in the workforce [17], a firm foundation for building a program of nursing effectiveness science was established (see Figure 1).

In the initial period, while a successful track record was being established, by the joint Clinical Chair and

Table 2: Changes in clinical practice following local primary, secondary, and translational research.

Clinical area involved	Change in practice
Community services	(i) Implementation and funding of the Waterworx Continence Centre. This community-based model of service provision was taken up by other Queensland health districts.
Intensive care unit	(i) Implementing and evaluating the introduction of an ICU discharge liaison nurse position. (ii) Production of patient/family information booklets for ICU.
Coronary care unit	(i) Implementation and evaluation of nurse-led care for heart failure patients.
General medical-surgical areas	(i) Management of peripheral IV infusions in children and in adults: removal on clinical indication. (ii) Followup of patients following total hip replacement surgery. (iii) Improved consent procedures and appropriateness of decision making for blood transfusions. (iv) Clinical trial of different pin-site management protocols. (v) Review of predischarge patient information in surgical wards. (vi) Production of evidence-based clinical guidelines and patient information on the management of constipation in middle-aged adults. These materials are now produced by the Australian Department of Health and Ageing. (vii) Development and implementation of the Renal Unit Clinical Nutrition Decision Support Algorithm.
Mental health	(i) Introduction and evaluation of patient-focused care in an acute psychiatric setting. (ii) Introduction and evaluation of a social development programme for young men with schizophrenia.
Aged care	(i) Design and evaluation of a dementia training program for aged care workers.
Paediatrics	(i) Introduction and evaluation of the program for adolescents with chronic illness. (ii) Introduction and evaluation of the Fun Not Fuss with Food program, ongoing involvement with the project suggests that this will be implemented statewide.

teams of clinicians, there were two interlinked strategies that helped the health service appreciate the value of the joint Clinical Chair. These strategies were increasing the number of clinicians who successfully completed research-based Masters Programs and engagement in smaller projects that resulted in clinical practice changes within the local health service. Examples of research studies that resulted in changes in practice are listed in Table 2.

By 2005 RCCCPI was expanding and the number of university researchers working in collaboration with clinicians, in a number of health services in southeast Queensland, was expanding. These nurse researchers brought additional skills in effectiveness science that, in turn, led to greater grant success. Randomised controlled trials and translational research studies became the norm for the group. One team was successful in attracting over AUD 500,000 for a randomised controlled trial of routine removal of peripheral intravenous catheters compared to removal on clinical indication, from the Australian National Health and Medical Research Council (NHMRC) (similar to but much smaller than the US National Institutes for Health). The NHMRC traditionally allocates less than 3% of its funds to research lead by nurses, so this was a considerable breakthrough for the team. This grant success, and the ultimately successful completion of the research project, would not have been possible without the excellent collaborative working relationships, developed over these past years, between the university academics and their clinical partners, in a number of hospitals in southeast Queensland.

6. The Next Step

Under the transformational leadership of the RCCCPI Director, researchers were able to formalise links with a number of international research teams, continue to strengthen their clinical collaborations, and expand their research capacity. Health-service-based clinical nurse researchers were offered adjunct positions with RCCCPI (i.e., these researchers were employed by their hospitals but were given adjunct or honorary positions in Griffith University). One of the RCCCPI adjunct Professors at another hospital in southeast Queensland had a strong link with the Cochrane Collaboration Wounds Group. This connection allowed the group to develop skills in undertaking Cochrane systematic reviews. These activities were successfully refreezing the academic and clinical environments into one where research was the norm, especially in the acute care, in-patient areas of a number of southeast Queensland health services (see Figure 1). The RCCCPI Director with assistance from other Griffith University Professors and the joint Clinical Chair then led the team in a successful application to become an NHMRC Centre of Research Excellence. The NHMRC manages the Australian government's competitive grant process that funds health-related research. In addition to managing the competitive process for Project Grants, Program Grants, and a variety of Research Fellowships, it also funds a very small number of centres for research excellence. The Centre for Research Excellence in Nursing Interventions for Hospitalised Patients (NCREN), established in 2011, focuses

on providing evidence to improve the nursing care of a broad range of hospitalised patients who have compromised skin integrity and/or require symptom management. These two particular areas were chosen because of (1) their high risk and high cost; (2) the research expertise within the team; and (3) Registered Nurses are largely responsible for patient care related to both skin integrity and symptom management. This is the first ever NHMRC Centre of Research Excellence to be awarded to a centre focused on nursing. NCREN now sits within RCCCPI as one strand of research. Both university academics (including the joint Clinical Chair) and clinicians in the local health service are named investigators within this new centre for research excellence, a clear statement of the strength of the clinical bridge.

In line with the thoughts of the original leaders who envisioned the joint Chair, Clinical Nursing Research, it became clear that the success of the collaboration and the strength of the clinical bridge could support the growth and evolution of the joint Clinical Chair position. In 2006 Griffith University appointed a specialty Clinical Chair with another southeast Queensland hospital in Critical Care Nursing. Then in 2011 Griffith University and the health service on the Gold Coast were successful in securing funding for a Chair in Midwifery from the Department of Health. When the incumbent of the Chair, Clinical Nursing Research, resigned in early 2011, the health service and Griffith University decided that the groundwork had been accomplished and that it was time for the Chair to evolve from a generic Chair to a more focused Chair in Acute and Complex Care Nursing. There are also longer term plans to appoint clinical chairs in other specialist areas such as mental health nursing, aged care nursing, and community care.

NCREN has been funded for five years and the team of researchers involved are back at the first element in the model depicted in Figure 1. The increased research activity demanded by NCREN's success will put stress on the clinical bridge. As clinicians struggle to maintain their standards in the face of increased clinical demand and now increased research demand, it behooves the research leadership to remain cognisant of the need for followership which is inherent within the models of servant and transformational leadership which have been manifestly successful to date.

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Research Article

Innovative Simulation Strategies in Education

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The use of simulation in the undergraduate nursing curriculum is gaining popularity and is becoming a foundation of many nursing programs. The purpose of this paper is to highlight a new simulation teaching strategy, virtual reality (VR) simulation, which capitalizes on the technological skills of the new generation student. This small-scale pilot study focused on improving interpersonal skills in senior level nursing students using VR simulation. In this study, a repeated-measure design was used to evaluate the effectiveness of VR simulation on improving student's performance over a series of two VR scenarios. Using the Emergency Medicine Crisis Resource Management (EMCRM) tool, student performance was evaluated. Overall, the total EMCRM score improved but not significantly. The subscale areas of communication ($P = .047$, 95% CI: $-1.06, -.007$) and professional behavior ($P = .003$, 95% CI: $-1.12, -.303$) did show a significant improvement between the two scenario exposures. Findings from this study show the potential for virtual reality simulations to have an impact on nursing student performance.

1. Introduction

The use of simulation in health care education is gaining popularity and is becoming a foundation for many undergraduate nursing programs. Most of the studies in the area of medical simulation focus on high-fidelity simulators or task trainers. However, there are potential correlations between the effectiveness of mannequin-based simulators and other types of simulation including virtual reality simulation. According to Gaba [1], simulation is a "technique" not a technology and focuses on recreating real-life situations to allow students to practice or gain skills in a safe environment. Many simulation centers use a variety of simulation techniques including low-fidelity task trainers such as IV insertion arms and high-fidelity human patient simulators, such as Laerdal's SimMan. High-fidelity mannequin-based simulation has been proven to be effective in both knowledge and skill acquisition and transfer [2–5]. A recent systematic review by Lapkin et al. [6] found that simulation improves critical thinking skills, knowledge acquisition, and the ability to identify a deteriorating patient. Another systematic review by Harder [7] found the use of simulation, when compared to other teaching methods, and improved health care students skills in the majority of studies examined.

Human patient simulators are beneficial for working with students in many clinical patient situations; however, other methods of simulation, such as simulations in virtual environments, may be appropriate for certain settings and learner objectives and can be used in addition to mannequin-based simulation. The advantage to using other methods of simulation such as virtual simulation may increase student exposure to simulation in areas where access to a simulation center is limited. The ability to facilitate active learning in multiple venues increases the opportunities for students to gain experiential learning critical to their success. The current generation of students is exposed to more computer based learning techniques than previous generations and social networking is a common way students engage with each other both in and out of the classroom. These computer savvy students or digital natives, people who were born into and raised in the digital world [8], are likely to be comfortable engaging in virtual simulations, therefore making this a viable simulation technique.

The purpose of this paper is to highlight a virtual simulation technique that capitalizes on the technological skills of this new generation of students with the purpose of developing key interpersonal skills (e.g., communication, delegation, conflict management, decision making, etc.) critical

to the success of the new graduate nurse in the clinical environment. Increasing the amount and types of simulation exposure could enhance overall student learning and allow for the best utilization of simulation resources.

Education for nursing students can be challenging when only random learning opportunities are available, and clinical experiences are dependent on the patient population or current practice environment. Thus, no assurance of knowledge acquisition of many vital concepts, such as conflict management, empowerment, delegation, ethics, and priority setting can be made. Simulations provide students with an opportunity to practice their skills in a safe environment, allowing for skill refinement with repeated exposure over time.

The use of simulation has increased in many nursing programs and due to this increase in use it may be difficult to schedule all of the simulations necessary to provide students with a comprehensive skill set upon graduation. One avenue for overcoming these barriers is the use of a virtual environment or virtual world as a representative training area for students to engage in simulations that focus on interpersonal skills such as communication or critical thinking skills. A virtual world is a "computer based, simulated multi-media environment" ([9], Page 233). A virtual world is typically set up to run over the World Wide Web wherein users create and identify themselves through an avatar, an online manifestation of self.

Some virtual worlds are called multiuser virtual environments (MUVEs) because they allow for more than one user to be in the environment and interact with other users in a synchronous fashion. The most popular and mature MUVE that is currently being used in education is Second Life [10]. Second Life (SL) is an online open-access MUVE developed and maintained by Linden Labs. SL allows anyone to open an account, set up a personalized avatar, and download their program for free. The technical requirements to run the program are found on many computers today. SL allows students to participate in real-life situations with other students in a MUVE through the use of avatars while receiving simultaneous interactive prompting and instruction by facilitators. Students have the ability to participate in any location where they can access SL via the internet. The use of avatars allows students a feeling of being "physically" present in the SL environment, allowing training to be in a safe, controlled setting where students may practice and enhance their skills [11].

SL has been used as an educational platform for many different medical, health, and nursing skills, such as identifying certain heart sounds, assessing patients, and engaging in reflective practice [9]. It allows students to gain experience in real-life situations in an environment that can be facilitated or set up by the educator. Students are able to gain the appropriate skills and make clinical decisions based on their learning while avoiding mishaps in patient safety that could occur in an actual clinical area. In a virtual learning environment, no harm is done to patients if an incorrect procedure or medication is administered. Unfortunately to date, there are few studies that examine the effectiveness of MUVE's such as SL on student knowledge and/or skill acquisition. This is due in part to the newness of the technology and the challenges in studying the environment. A brief summary of the few studies found in the literature as follows.

In one study, the use of a virtual learning environment led to better reflection between online students, which may support the creation of communities of practice [9]. In another study, paramedic students using SL for problem-based learning, found the environment more authentic and collaborative than using paper-based problem solving scenarios. The researchers also found the SL environment allowed for feedback to the students from their virtual "patients" which increased the benefit of the learning envi-ronment for the learners [12].

Commercial and educational institutions are using SL or other MUVE's to assist in their training/educational programs and curriculum. MICHELIN automotive tires developed a training environment in SL to train their information systems (IS) personnel in the United States, Europe, and Asia to ensure global alignment of processes and IS solutions [13]. The University of Kansas Medical Center uses SL to run training simulations for anesthesia induction in a setting that replicates their current operation room [13]. There are many uses for SL, but very few studies are published yet.

One study did focus on comparing the outcomes of virtual reality (VR) training to mannequin-based simulation. In this study [14], subjects were assigned to either a mannequin-based simulation or a VR simulation for team training in the emergency department. The results indicated both groups showed significant improvement in performance after completing the training. Simulation can be an effective education and training method educators and faculty can use to facilitate student learning, particularly in the health professions where certain critical skills are necessary for optimal and safe patient care. Therefore, measuring the ability of simulation, in particular virtual simulation, to improve learner skills is of vital importance.

2. Conceptual Framework

The conceptual framework used to guide this research is based on Ericsson's [15] work on expertise. Ericsson's framework posits that to acquire expert performance one must engage in deliberate practice activities that are clearly focused on improving some aspect of performance. Most students tend to improve performance with experience; however, Ericsson's theory states that experts are those individuals who continue to improve beyond the level needed to perform adequately and become recognized as experts in their domain. Although students are just beginning in their skill development the underpinnings of Ericsson's theory can help educators focus deliberate efforts to improve selected skills or tasks. During this process, students are instructed to improve certain aspects of their performance for a well-defined task, such as communicating to a health care provider regarding a patient's status. The student is then given immediate detailed feedback on their performance which they can reflect upon and continue to practice during subsequent training sessions. Simulation is one of the techniques that can be used to

engage professionals in deliberate practice of skills and has the ability to improve performance in professionals that require deliberate, goal-oriented, and structured practice [14].

3. Materials and Methods

The specific aim of this study was to examine the relationship between student learning and use of virtual simulated clinical experiences. A repeated-measure design was used to evaluate the effectiveness of virtual simulation on improving student's performance over a series of two virtual simulation scenarios. This study was conducted over one academic semester with a convenience sample of senior nursing students at one midwestern, university-based School of Nursing. The students were traditional undergraduate students taking Leadership and Management. Student demographic information was not collected; however, the majority of students were young, post high school students completing their first degree. At total of 61 students participated in this study. They received education in the traditional manner (i.e., lecture and seminar discussion) in addition to the two virtual simulations. Institutional Review Board review was obtained, and the study was considered exempt.

3.1. Instruments. Student (avatar) performance in virtual scenarios was measured using 8 of the 10 items from the Emergency Medicine Crisis Resource Management (EMCRM) tool, developed by Youngblood et al. [14]. This tool was developed to evaluate participant's crisis management skills in a virtual emergency department. The EMCRM assesses subject's team leadership skills, including utilization of information and resources and overall ability to communicate and facilitate task completion. Initial reliability testing of the tool was supported with a Cronbach's alpha of 0.96 [14]. The tool was reduced by two items (those items did not apply to the virtual simulations designed for this study) to measure nurse's performance in a crisis situation in an acute care unit setting. The remaining categories included leadership, communication, delegation, attention, information utilization, resource utilization, early call for help, and professional behavior. The definition of these categories was adjusted to account for nursing student expectations of behavior. Cronbach's alpha on the revised EMCRM was 0.9 as measured during this study.

Student satisfaction was measured through a satisfaction questionnaire developed for the initial beta testing of the SL environment [16]. The six-question survey measured student's perceptions on a 5-point Likert scale (strongly disagree to strongly agree). Questions included SL experiences helped prepare me for clinical, SL experiences resembled a realistic clinical environment, SL experiences reinforced the course objectives, SL experiences were an effective learning experience, SL experiences improved my decision making skills, and overall the SL experiences were a positive experience. Four open-ended questions were also asked: what I like most about the experience in SL, what I liked least about the experience in SL, and how do you rate this experience in comparison with other simulations (i.e., SimMan) and suggestions for improvement.

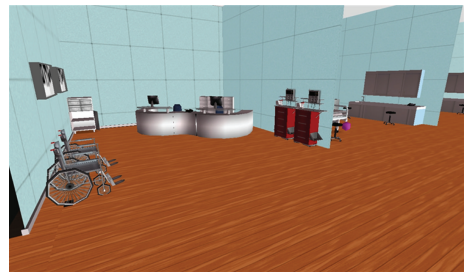

Figure 1: Second life nursing station.

Figure 2: Second life patient care room.

3.2. Intervention. The intervention consisted of two virtual scenarios that the students participated in at two different times during one academic semester. Prior to creating the simulations, a hospital unit was developed on the university owned space in SL, which was subsequently used as a training environment for the virtual simulation scenarios [16]. The virtual unit consists of eight acute care beds with mannequins (patients), a nursing conference room, a nursing station, and a variety of medical equipment staged throughout the unit to enhance realism of the unit (Figures 1 and 2). The unit was constructed for minimal cost as the University already owned the space and had developed the building used. The costs included buying items for the unit (e.g., hospital beds, desks, equipment, etc.) and some developer time to put up walls and create or modify objects used on the inside of the building. The total project cost was under $3000. The University provided in-house experts to the project team to support the training and development of the facilitators using SL for this project.

Two scenarios were developed by two content and simulation experts. Objectives for the scenarios were developed in alignment with the Quality and Safety Education for Nurses (QSEN) recommendations (Cronenwett et al. [17]) and The Baccalaureate Essentials for Practice [18], in addition to specific course and overall nursing program objectives. Specifically, objectives were focused on QSEN's teamwork, collaboration and patient safety objectives and the Essentials IV and VIII focusing on interprofessional communication and professionalism.

As described in Table 1, Scenario 1 involved a safety issue and a medication adverse event, and Scenario 2 involved a difficult interprofessional communication situation. Each

Table 1: Virtual scenarios.

Scenario	Objectives	Roles	Situation	Expected actions
(1) Medication safety	(1) students will demonstrate the correct response to a medication error; (2) students will use appropriate communication skills when delivering peer feedback; (3) students will demonstrate leadership skills in difficult situations.	(1) Bedside day nurse (2) Charge nurse (3) Bedside night nurse	The scenario starts at the beginning of the shift as the bedside nurse is given instructions to hang an antibiotic ordered for the patient. When he/she arrives at the bedside they find an empty bag of a different antibiotic attached to the patient's intravenous line. The antibiotic hanging was not ordered for the patient, has another patient's name on it and the patient is allergic to the medication. The student is told to proceed as they would if this happened in the clinical environment.	(1) assess the patient for a reaction to the antibiotic and provide any necessary emergency interventions; (2) stop the antibiotic; (3) notify the physician and carry out any orders given; (4) notify the charge nurse; (5) complete an incident report; (6) follow up with the night nurse who hung the antibiotic found hanging at the bedside.
(2) Interprofessional communication	(1) students will recognize inappropriate communication; (2) students will use appropriate conflict management skills; (3) students will use resources appropriately.	(1) Bedside nurse (2) Charge nurse (3) Physicia (played by faculty) (4) Assistiv personnel Patient family member	The scenario starts as the student playing the role of the nurse is directed to go to the bedside and begin discharge teaching for a patient who is waiting to go home. A physician comes in and is upset about the care related to a different patient and begins a confrontational verbal dialogue at the bedside. The student is again directed to handle the situation as they would if they were in the clinical environment.	(1) get the physician away from the bedside to continue the conversation; (2) use conflict management skills to resolve the situation; (3) get the charge nurse involved if situation continues; (4) conduct any necessary followup with the situation the physician was upset about.

scenario required the students to use a similar skill set (patient safety, leadership, communication with health-care providers, feedback to colleagues, appropriate use of resources and followup, and delegation). The scenarios were developed and beta tested using second career nursing students and faculty prior to use in this study [16]. Students in this study were given an overview of SL during the didactic portion of their fall course. Each student was also given a Power Point handout that described the basics of SL such as how to set up an account, create an avatar, move your avatar, and use the chat function. Students were encouraged to develop their own avatars and explore the world prior to the simulations. For each simulation, students who played a role in the scenario (e.g., role of RN, unlicensed assistive personnel, patient) went to the school computer lab and logged into SL, while the remaining students were in another classroom watching the virtual interaction via LCD projector through one of the facilitator's avatars. The students used avatars that were already created and were present in the training environment. The students needed to use the directional keys on the keyboard to move their avatar and a texting function called chat to "speak" to each other. These were the only skills necessary to participate in the virtual simulations.

Prior to each simulation the students who played a role in the virtual environment using an avatar were once again given a brief overview of SL and how to manipulate their avatars. They had an opportunity to practice for a few minutes moving their avatars and using the chat function before the simulation began. A facilitator was present during the entire simulation to answer questions or troubleshoot any problems the students had during the simulation.

Five groups of approximately 15 students participated in the two scenarios at two different points in time (in Scenario 2 two of the five groups participated at the same time). It is important to note that not all students were actually able to play a role in the scenarios. Most students were observers watching the simulation scenario. This is consistent with mannequin-based simulation in which students may play roles in the simulation or observe the simulation. All students, however, do participate in the debriefing of the scenario and are exposed to key learning points. Scenario

Table 2: Results comparing scenario 1 (time 1) to scenario 2 (time 2).

ECRM	Scenario 1 mean	Scenario 2 mean	Significance (P value)
Leadership	4.13	4.22	.643
Team communication	3.79	4.33	.047*
Work delegation	3.64	3.75	.698
Attention allocation	3.92	4.10	.456
Information utilization	3.76	4.25	.085
Resource utilization	3.54	3.42	.783
Early call for help	3.70	3.25	.359
Professional behavior	3.83	4.54	.003*
Total score	30.32	31.90	.424

* Indicates significance $P < .05$.

1 was conducted in September 2009, and Scenario 2 was conducted in November 2009. The students were all given background information on the scenario (i.e., some students playing roles in the simulation were given cue cards if a certain response was required during the simulation), and then the scenario was started. The students who played the roles were volunteers from the larger group. The communication was done using the text chat function in SL so that all students could see the communication interaction. The text chat function in SL is similar to most online chat programs and allows the students to type in their communication and others to respond. The communication stream is visible on the computer to all avatars in the area. One of the facilitators ran the scenarios in SL by giving the students their instructions via text chat and passing note cards (written information that can be passed in-world between avatars) when appropriate. The simulations ran for approximately 10–15 minutes. At the conclusion of the scenario, all of the students (including those who played a role) met in the classroom and were thoroughly debriefed by a trained facilitator. Text chat logs from the simulation were saved for future analysis. Students who did not play a role in the scenario were asked for specific feedback during the debriefing on how they might have handled the situation. All 61 students participated in both virtual simulations; however, the majority of those students participated as observers. Different students played roles in each scenario allowing a larger portion of the 61 students to directly participate. After the completion of the virtual scenarios all students were asked to complete the satisfaction questionnaire.

3.3. Data Collection. During the scenario only the charge nurse role and the bedside nurse role were evaluated using the shortened EMCRM by the trained observers. The other roles played by students (tech and family member) and facilitators were part of the scenario flow but not scored. The bedside role was scored in all the scenarios, but the charge role was only scored if the charge nurse was called upon by the bedside nurse to help out which accounts for the different number of observed cases between scenario 1 and 2 (8 versus 7). In other words, there were 8 observations for scenario one and 7 observations for scenario 2 that were analyzed in the study.

Multiple raters independently observed the subjects' performance in key roles (day RN or bedside nurse, charge RN) on both scenarios. The raters were trained by the researchers prior to the virtual simulations in the use of the tool and the behaviors that would indicate the various scores. Each rater was given an overview of the EMCRM tool and the definitions for each item. Examples of what that behavior looked like were discussed. All raters observed the simulation at the same time and scored their sheets. After the initial scenario, raters were able to compare their results and any disagreements in ratings were discussed immediately after the simulation. Raters then continued to score each subsequent simulation independently. The raters used a 5-point Likert scale (1 = poor; 5 = excellent) to assign scores for each of the 8 items on the scale, for a total possible score of 40. These scores were then averaged for a single consensus score for each subscale for each group and role. Scenario 1 had a total of 8 roles (bedside nurse and charge nurse) for five groups, and scenario 2 had 7 roles (bedside nurse and charge nurse) for four groups that were scored. Data was entered into PASW for Windows, Version 17.0. Descriptive statistics for all continuous variables were computed, and independent t-tests were performed to compare student performance over time.

4. Results and Discussion

As noted in Table 2, overall student performance (total EMCRM score) on the second virtual unit scenario (average score 31.90, SD 3.19) was slightly better than performance on the first scenario (average score = 30.32, SD 4.09) showing some improvement with exposure to this type of computer-based simulation.

Independent t-tests were performed to compare the average value of each of the subscale variables between Scenario 1 and Scenario 2 to determine if there were significant differences in performance based on repeated exposure. Team communication ($P = .047$, 95% CI: -1.06, $-.007$) and professional behavior ($P = .003$, 95% CI: -1.12, $-.303$) showed a significant difference between the two scenario exposures. Specifically, the student's ability to communicate with the team and their professional behavior improved from scenario 1 to scenario 2.

Table 3: Survey responses ($n = 61$).

Variable	N	Minimum	Maximum	Mean	Standard Deviation
Preparation for clinical	61	1.00	5.00	3.14	.94
Resemblance of realistic clinical environment	60	1.00	5.00	3.18	1.05
Reinforced course objectives	60	1.00	5.00	3.55	.87
Effective learning experience	61	1.00	5.00	3.07	.98
Improved decision making skills	61	1.00	5.00	3.28	.92
Overall positive experience	61	1.00	5.00	3.32	.85

* Scores range from 1 = strongly disagree to 5 = strongly agree.

The satisfaction survey was completed by 61 students. Student satisfaction scores (Table 3) showed that students rated the variables slightly better than neutral on their agreement with the variables. The scores ranged from 1 (strongly disagree) to 5 (strongly agree). Preparation for clinical was rated at a mean 3.14 (SD .94), realism of the environment was 3.18 M (SD 1.05), and reinforced objectives was 3.55 M (SD .87). Reinforced objectives was the highest scoring item. Consequently the effectiveness of the learning environment scored the lowest at a mean of 3.07 (SD .98). Improving decisions scored 3.28 M (SD .92), and the overall experience was rated 3.32 M (SD .85).

Student comments were mixed. One student responded, "I could see this sort of thing happening in a real clinical setting. The real-life scenario (i.e., charge nurse scenario) helped me make better decisions. . . ." Another comment, "I found the experiences displayed in second life were realistic and discussing what could have/should have been done was helpful. . . ." Several comments indicated students did not like the text chat function and found it difficult to read when they were observing. "The simulations were very realistic. If there is a way to make the typed font bigger it would be easier to read". Another comment, "The Second Life is an interesting approach to clinical—but I prefer the real-life sim because I prefer the verbal "out loud" conversation—it is more real-life."

The EMCRM results show that team communication and professional behavior did show significant improvement. This may have improved in part because the students became more comfortable with the virtual world and the interaction with other members (avatars) in addition to the learning that occurred during scenario 1. Subjects in this study did demonstrate improvement in their team leadership skills (total EMCRM score) from scenario 1 to scenario 2; however, the improvement was not significant. Many of the behaviors evaluated in the virtual scenarios are complex, such as work delegation and attention allocation, and the two scenarios may have not been enough practice to show significant improvement in those areas. It is also important to note that there were a small number of cases in each scenario. Despite the fact that 61 students participated in the virtual simulations, only 8 cases were rated in scenario 1, and 7 cases in scenario 2 were scored because only 2 students could play a role in each of the virtual simulations.

This pilot study demonstrates that participation in VR simulation helps students improve performance; however, more work is needed to determine how significant the VR simulations contributed to this learning. These results are encouraging as further research using pre- and post-tests could further evaluate improvement in performance with repeated exposure, deliberate practice, and familiarity with virtual world learning.

5. Limitations

Several limitations have been identified in this study. One obvious limitation is the study's small sample size which impacts the power of the study, perhaps increasing the chance of a type II error in data analysis. There were a small number of cases for each outcome variable of interest and as such, the bounds of normality may be stretched. The sample for this study was a convenience sample of fourth year nursing students from the same university, making generalizability of results to other populations unknown, and a second study limitation. Interrater reliability was not conducted as the scores of the raters were averaged into a single consensus score for each simulation.

6. Conclusions

Virtual world simulation environments offer a unique and potentially cost-effective method of teaching nursing skills related to leadership and management skills in facilities that have access to virtual environments such as SL. The university owned space in SL provides a virtual unit environment that has the potential to offer valuable, practical, real-world experiences for future nursing students. The total cost of the project to set up the virtual hospital was under $3000. This presumes that one has access to a space in SL that is already being maintained, and no additional costs are incurred for space purchase and ongoing costs such as lease fees or information technology fees. The cost would be much higher for educators who do not have access to SL. The cost savings involved would be a savings on lab fees and supplies associated with high-fidelity simulation centers. This type of environment allows for the practice and learning of interpersonal skills such as communication, teamwork, and delegation which are critical to patient safety and improved patient outcomes.

Students are challenged with learning both technical and nontechnical skills to achieve competency in their future roles as practicing nurses. Ericsson's [19] work in the area

of deliberate practice and expertise provides a framework for educators to use in assisting nurses and nursing students in achieving these skills. The results of this study demonstrate that improvement can be seen over time as students practice those skills. However, this improvement will need to be reinforced through subsequent simulations, and SL can provide a less expensive training environment that can be used to practice many nontechnical skills such as clinical judgment, teamwork, leadership, and communication. It can also provide an opportunity for nurses to participate in simulations from home or anywhere they can access the internet, providing educators with a new, flexible option for training. In addition, this method of simulation may maximize opportunities for multidisciplinary teams to interact and practice necessary skills for high quality of care. Adding virtual simulations to well-established curriculum that includes mannequin-based simulations can be an added benefit and allow for expanding learning opportunities for students.

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Research Article

The Effectiveness and Clinical Usability of a Handheld Information Appliance

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Clinical environments are complex, stressful, and safety critical—heightening the demand for technological solutions that will help clinicians manage health information efficiently and safely. The industry has responded by creating numerous, increasingly compact and powerful health IT devices that fit in a pocket, hook to a belt, attach to eyeglasses, or wheel around on a cart. Untethering a provider from a physical "place" with compact, mobile technology while delivering the right information at the right time and at the right location are generally welcomed in clinical environments. These developments however, must be looked at ecumenically. The cognitive load of clinicians who are occupied with managing or operating several different devices during the process of a patient encounter is increased, and we know from decades of research that cognitive overload frequently leads to error. "Technology crowding," enhanced by the plethora of mobile health IT, can actually become an additional millstone for busy clinicians. This study was designed to gain a deeper understanding of clinicians' interactions with a mobile clinical computing appliance (Motion Computing C5) designed to consolidate numerous technological functions into an all-in-one device. Features of usability and comparisons to current methods of documentation and task performance were undertaken and results are described.

1. Introduction

Physicians and nurses are highly mobile workers who operate in complex, stressful, and safety critical environments. Frequent interruptions, rapidly changing patient status, complex clinical presentations and information from multiple streams all combine to increase the cognitive load of practitioners and create the potential for medical error. These challenges have created a demand for technological solutions that will help clinicians manage information and make optimal decisions in this demanding work environment. The plethora and diversity of highly portable, increasingly compact, and powerful information and communication technology (ICT) devices on the market is evidence of an industry response to this growing demand.

Untethering a provider from a physical "place" with mobile technology and delivering the right information at the right time and at the right location are expectations for effective and safe clinical practice. These technological solutions can, however, contribute to the problem. Clinicians are confronted with numerous different devices to complete a series of related, yet separate actions. It is not uncommon to see practitioners with a mix of communication devices, barcode readers, and computers on wheels—some being worn around the neck, hooked to belt loops, and stuffed in pockets, while others are being pushed up and down hallways. This is in addition to stethoscopes, otoscopes, and other clinical devices traditionally carried by a provider.

This problem of device overload or "technology crowding" is now becoming an additional clinical millstone. Indeed, recent studies are pointing to marked productivity losses in environments where high technology dependence and technology overload intersect [1]. Orchestrating numerous devices with a variety of functions (some which overlap), increases clutter and cognitive load, distracting the user's attention away from the tasks at hand. Losing focus in the clinical environment contributes to increased opportunity for medical error [2, 3].

In recognition of the problem of technology crowding, a shift from numerous independent single-function devices to consolidated mobile information appliances (such as i-pads, multifunction smart phones, and portable clinical

tablet PCs), is occurring. While this shift is appropriate and welcomed by most, it is dangerous to consider device consolidation as a panacea to the information management challenges raised earlier. As with any new technology, it is important to fully understand how the technology is utilized in the real-world environment, the degree of usability that it possesses, the impact it may have on users, and its effect on workflows. This is of great importance, particularly in safety-critical environments where prediction of sequelae is difficult and electronic propagation of error can be immediate and far reaching.

Studies that compare how health IT is *actually used*, versus how the device was *designed to be used,* are necessary. There are numerous instances of a misalignment of design and actual real-world use of health IT in the literature. Han et al. [4] demonstrated unexpected increases in mortality in a pediatric ICU after the implementation of a commercially available computerized provider order entry system (CPOE), while Koppel et al. [5] uncovered 22 types of medical error risks facilitated by CPOE. Ash et al. [6] specifically focused on the unintended consequences of health IT, describing how and why errors occur when health IT is implemented without investigations of how patient care systems are actually used in the real-world clinical environment. Vincente [7] makes the important point that the biggest threats to both safety and effectiveness arise from situations that are "unfamiliar to workers and that have not been anticipated by designers" (page 22).

Studies and experience show that busy clinicians will not tolerate technology, software, or processes that impose workflow barriers or that introduce additional difficulty into already complex task performance. Workarounds, a common response to suboptimal technology, are a frequent result of problems with technology design. Workarounds can result in use of the system in ways not anticipated by the designer; echoing the point made by Vincente [7]. When workarounds occur, built-in safety features are often circumvented, and the potential for a cascade of negative downstream effects can occur [8]. For example, Koppel et al. [9] cite observations of nurses who carry extra copies of barcoded patient wristbands to avoid multiple trips to the drug carts. In effect, this workaround disabled device safety alert features that resulted in wrong patient-wrong drug errors.

Workarounds and unanticipated uses of technology are becoming increasingly dangerous in healthcare environments. In this era of healthcare reform, accountability and reimbursement for "meaningful use" of health information technology, the impetus for comparisons of design intention with actual use is highly important. Improved design and reduction of the negative unintended consequences are the goals of health information technology usability and impact studies.

2. Study Goals and Questions

With these factors in mind, we undertook a study to gain a deeper understanding of clinicians' interactions with a mobile clinical computing appliance designed to consolidate numerous technological functions. Features of usability and comparisons to current methods of documentation and task performance while using a portable PC (mobile clinical computing appliance) were of particular interest.

The following specific questions were the foci of the study.

(1) What specific themes define the usability challenges that clinicians encounter when using a mobile device to assist them in completing typical clinical tasks?

(2) How usable is the C5, viewed as an important instance of a class of devices that are increasingly used by clinicians in patient care settings?

While this study focuses on one device, and the results are not generalizable beyond the specific device tested, the usability themes that emerged from pursuit of question 1 and methods employed in this study can be applied to a wide range of devices and can help guide the way usability of such devices is assessed in the future. The approach employed in this study is intended to be of particular applicability to multifunction devices such as the C5.

3. Methods

3.1. Device. We studied a newly introduced "all-in-one" mobile hand-held PC, the "Mobile Clinical Assistant" (or MCA C5) that was specifically developed to address the challenges of technology crowding and device overload in busy healthcare environments. The C5 mobile PC incorporates wireless technology, Windows operating system, a 10.4 inch color display screen, a barcode scanner, a digital camera, a RFID reader, and a biometric fingerprint reader. The device weighs 3.3 pounds and also has built-in loudspeakers, a microphone, a handle, and a tethered writing stylus. The C5 has a water resistant, sealed case to allow disinfection using equipment grade liquids (such as Viraguard) between patient encounters. The device is "ruggedized" to withstand a drop from 5 feet onto concrete. The C5 can access and display clinical information from external servers; no personal health information is persistently stored on the device itself. Finally, the device contains an accelerometer which enables the screen display to rotate based on device orientation, and an antitheft system which can be set to alarm, shut down, and delete all content in temporary storage if the device is moved outside the work environment, where its use is authorized.

3.2. Subjects. Study subjects were a convenient sample of experienced clinical nurses, recruited via word-of-mouth and by advertisement on several nursing listservs.

3.3. Setting. Data were collected in a simulated clinical environment as these subjects completed a series of tasks designed to reveal the strengths and weaknesses of the C5's design. We conducted both phases of this study within a large University School of Nursing 30-bed patient care simulation laboratory, and specifically in a small side classroom that is structured to represent a 3-bed intensive care unit. Within this room, there are 2 full-size Laerdal "SimMan" clinical

mannequin simulators and one infant "SimBaby" in a bassinet.

3.4. Tasks. With simulated patient data provided by an electronic health record system (Eclipsys Sunrise Clinical Manager—SCM Version 4.5), subjects performed tasks related to barcode medication administration, digital photography of a stage 4 pressure ulcer for wound documentation, and an assessment of a newborn with documentation. Each of these tasks was chosen as representative of actions that a nurse might undertake in the course of a normal clinical workday.

For the purpose of the use of the C5 digital camera testing/wound assessment, a partial body mannequin with a variety of skin ailments was used. This partial mannequin is designed to illustrate a variety of skin conditions for use by educators. For example, a very life-like stage 4 sacral deep pressure ulcer with exposed bone, tissue tunneling, wound edges, exposed muscle, and exudate is present as sutures, rashes, stage 1 and 2 pressure ulcers, bruises, and nevi. The stage 4 sacral pressure ulcer was used for a portion of digital photography component of the study. The subjects also used a full-size SimMan mannequin to approximate camera use with a "live" patient who required turning and positioning to obtain a picture of the sacral pressure ulcer.

The barcode scanning component of the study was implemented via the use of proprietary forms software and barcodes constructed specifically for this study. Barcoded badges, medications, and patient ID bands were created and used in the testing of the C5 barcode scanner. ID bands were attached to mannequins and contrived "staff badges" with a barcode on the back were created and worn by subjects. "SimBaby" was used for the assessment procedure using the C5. All studies were completed in the same room under similar light conditions (mid-day).

3.5. Study Design. Following IRB review and approval, the study was conducted with two separate phases using two different subject samples. Phase 1 tested the procedure and the tooling prior to enrolling and studying the primary participants. Two experts were used for Phase 1. In Phase 1, user and environmental analyses were conducted to profile the characteristics of system users and the environment in which they interact. Heuristic evaluations and cognitive walkthroughs, a type of usability inspection where evaluators interact with the system and examine the device for usability issues, were also performed in Phase 1. This trial phase enabled the formal study procedures to be fine-tuned and the data collection procedures to be refined. The results from first part of the study will not be covered in detail in this paper.

Phase 2 of the study was conducted with 15 subjects to generate data illuminating the usability of the C5. Data were generated through ethnographic observations, surveys, and interviews of users during and after the performance of a series of the three tasks (documenting, photographing, and barcode scanning) while using the C5. The focus of this paper is on Phase 2. In Phase 2, subjects completed in random order three simulated tasks using the C5 device wound documentation using digital photography; barcode scanning with medication administration, and completion of a standard admission assessment on a newborn infant. Each participant completed the questionnaire after finishing all three tasks. Trained observers documented field observations, and subjects were asked to "think-aloud" as they worked through the scenarios.

3.6. Data Collection Methods and Instruments. As each subject completed the three tasks, the PI was taking notes, inquiring, encouraging think-aloud, answering, and probing/interviewing about specific actions. The field notes from the observations were included in the data analysis. The "think-aloud" protocols generated by participants were recorded directly by the C5 device and saved.

The questionnaire used in this study was adapted from the QUIS (Questionnaire for Use Interaction Satisfaction). QUIS is a long-standing, reliable, and valid usability checklist (http://lap.umd.edu/quis/). The QUIS was modified based on focus group input, adding specific items unique to the characteristics of the C5, and then content validity was determined by an expert panel in Phase 1. The resulting questionnaire was comprised of 7 sections: demographics (11 items, including years in practice and computing experience); overall user reaction (5 items); physical characteristics of device (13 items); device reliability (1 item); simulated device management activities (2 items); other topics (6 items); user opinions (6 items). Items used Likert-type response scales (e.g., Easy-Hard) or checklists (Yes-No). Each of the 7 sections also included an area for free text comments comparing the C5 with standard methods of similar task completion/documentation in clinical practice. The entire questionnaire took approximately 15 minutes to complete.

3.7. Study Procedure. Following consent, each subject's experience began with orientation to the C5. Subjects were taught how to use the C5 camera, the C5 barcode scanner, and how to document in Eclipsys SCM. Each subject was also oriented to the device, how to adjust the views based on arm positioning, how to use the writing stylus, how to insert and remove the device from a docking station, and how to change the battery and conduct the disinfecting procedure. Subjects were also instructed on the talk-aloud data collection procedure and asked to practice and demonstrate it prior to the start of the study to assure understanding and comfort.

The consenting and orientation took, on average, approximately 1 hour per subject. Subjects were allowed to question, practice, and repeat as many times as they felt necessary to come to a level of comfort with the device and the procedure prior to starting the study. Subjects personally determined how to hold the device and were encouraged to change positioning as necessary during the study. At that point, the study was begun, and the audio recorder (built in to the C5) was turned on. These audio files were later transcribed and analyzed. Following the completion of the study, the recorder was turned off, and subjects were given the questionnaire to complete.

3.8. Data Analysis and Usability Theme Identification. The PI, the research assistant, and two informatics experts assembled to code, analyze, and interpret the observational data and the subject voice recording (think-aloud) transcripts. To create the coding scheme for the transcripts, we employed an approach similar to that of Kushniruk et al. [10]. By reading three randomly chosen transcripts, all members of the team created individual lists of subject-expressed usability categories. Using a consensus process, the team then arrived at a single consolidated list of usability categories which were then used to classify and tag expressed comments in the audio files from all 15 subjects.

Each of the 15 transcripts was independently coded by two members of the team using the previously derived usability categories. Usability issues which arose and not represented in the original coding scheme were flagged for later consideration. Coding disagreements were settled by a third independent team member. The occurrence of each coded utterance was marked with a timing point so that, during analysis, the PI could return to that exact time marker on the audio file to listen and record any specific comments. The results from the coding of the transcripts were then matched to the 7 sections of the questionnaire and (along with observations from field notes) were used to complete the dataset for analysis.

The following example illustrates how the three data streams (questionnaire, observations, and coded transcripts) were consolidated. One question on the survey asked "How easy is it to use the camera during the process of documenting with the C5?" The subject's rating from the questionnaire was then supplemented with any instances from the subject's coded transcript of expressed difficulty with the camera. The PI's field notes were examined and any observations that highlighted user difficulty with using the camera were noted and added to the dataset. In example, observed difficulties with the camera included subjects struggling to depress the shutter button with the occasional accidental machine shutdown caused by hitting the on/off button located adjacent to the shutter button. The clustering of these three data streams created a deeper and multidimensional dataset of usability issues.

4. Results

4.1. Demographics. Of the 15 RN subjects, there were 2 males and 13 females. Twelve of the subjects identified themselves as White not Latino, 1 identified as Asian not Latino, and 2 identified themselves as White Latinos. All subjects were RNs; three were prepared at the baccalaureate level, ten had a master's degree, one had a PhD, and one had obtained postdoctoral training. Most of the subjects in the study were between 41–55 years of age. The average number of years of RN licensure in this sample was 21. The degree of comfort with the use of computers in the clinical setting for patient care purposes was assessed by participants as high—with all but two ranking themselves as "very comfortable." Two ranked themselves as "somewhat comfortable." The majority of the users estimated that they used computers in their clinical practice upwards of 50% of the time.

4.2. Usability Themes. The data from the questionnaire, observations, and audio recordings clustered into 5 themes. Several themes (1 and 3) included subthemes:

(1) input ease (with subthemes of TIP tool, barcode reader, and camera);

(2) portability;

(3) security/safety (with bacterial transmission included as a key aspect of safety);

(4) efficiency gains;

(5) general ease/intuitiveness.

4.3. Usability of the C5

4.3.1. Theme 1: Input Ease. The theme of "input ease" is a compilation of specific items in the consolidated data set that relate to ease by which data can be input into the C5. The input ease theme broke out naturally into subthemes based on the three different input modalities: TIP tool, barcode reader, and camera. The TIP tool was useable in two ways—by tapping and clicking with pulldown menus and onscreen keyboard or using the stylus like a pen with handwriting recognition. The TIP tool is not specific to the C5, it is a Microsoft feature, yet many of the subjects had no experience with the use of a TIP tool. It is included here due to its relative negative impact on usability comparisons.

TIP Tool. The results of the use of the TIP tool stylus-based input met with mixed results. Eight of the 15 subjects rated the TIP tool "tapping" input as somewhat to very difficult, and the field notes and coded comments revealed marked instances of difficulty and frustration. Subjects were observed to repeatedly tap the screen with increasing vigor while and expressing negative perceptions. In contrast, the TIP tool handwriting recognition was rated positively by 13 of the 15 subjects, with many expressing surprise at its level of accuracy. However, only 1 of the 15 subjects mastered the proper method of editing the handwriting, spawning creative yet inefficient workarounds. Frustration with the editing function was high, but the perceived value of being able to handwrite on the screen was a highly rated feature amongst most of the subjects.

Camera. Eighty percent of the subjects rated the digital camera built in to the C5 as a very positive feature of the C5. The participants voiced support for digital photography as a part of the patient record and believed that the impact of the camera on workflow and patient care was overwhelmingly positive. Recorded comments relayed comparisons with current methods of photography in clinical settings which revealed very inefficient processes of requesting a camera, locating it, assuring that the batteries were operational and similar. Several subjects stated that they would enjoy using such a camera when working with patients in chronic wound management settings to show the status of wounds that a patient could not easily visualize (such as sacral pressure ulcers) or to better document the nature of wounds for a

patient record. While supportive of the camera as a concept, 11 of the 15 participants found the C5 camera difficult to use. Problems included the location of the shutter button adjacent to the on/off switch, the positioning of the stylus tether directly in front of the lens, the low megapixels (2.0) which resulted in lower quality photos, and poor flash strength. In addition, subjects did not respond favorably to the process of focusing which required that the entire C5 be moved in and out (similar to an i-Pad) instead of being able to autofocus or zoom in with a focus button on the device itself.

Barcode Scanner. Usability of the barcode scanner was rated highly, with only 2 of the subjects rating the scanner to be "somewhat difficult" to use in the survey. The observational and the coded transcript data, however, provide additional dimensionality to the use of the barcode scanner and opportunities for improvement. In analysis of the remarks, the subjects were overwhelmingly positive about barcode scanning and were pleased that the C5 contained this feature. However, subjects voiced a concern about having to move the entire device to scan something, and about the limited range of the scanner (6–8 inches maximum). For example, the testing scenario included scanning an IV bag that was already hanging from a pole. One subject reached over the mannequin to scan a barcoded IV bag and dropped the device on the mannequin's head. Several expressed concerns about ease of scanning a patient's wristband and having to position the entire C5 device to do so.

Six subjects verbalized the value of bar coding and viewed it as an important safety feature. Others commented that it was good to have an "all in one device" because they were "already loaded with things to carry" and were not in favor of a documentation device and a separate barcode scanning device. Three subjects who were familiar with barcode scanning also commented that a barcode scanner located away from where scanning occurs "does not help me to improve safety or make my job easier" (paraphrased).

4.3.2. Theme 2: Portability. The portability theme included the benefit of being "untethered" from a fixed workstation in addition to perceptions of transportability/handling of the device. The portability of the device was rated from "valuable" to "very valuable" by 11 of the 15 participants on the survey. The transcripts and observation data supported the survey results with many verbalized comparisons of current practice with fixed workstations and the inefficiency of computers on wheels and/or fixed stations.

At the start of the study, every subject was encouraged to hold and readjust the C5 as needed and to use the built-in handle as he/she saw fit. Observational and transcript files reveal significant amounts of shifting and repositioning of the device that decreased over time. The autorotation of the screen was voiced by several participants as a necessary and positive feature. Five of the 15 participants asked for an accompanying "strap" of some sort so that they could have two free hands at times. Three other participants said that a strap would alleviate some of the concerns they had about the device weight. Twelve of the 15 subjects carried the device like a lunchbox in between task stations in the lab. Most of the subjects were observed to use the device like a clipboard or a medication tray.

While the majority (60%) of the participants rated the device's weight (3.3 lbs) on the survey as "neutral", all other ratings were skewed towards intolerable. The observational and transcript data highlighted concerns over weight, yet at the same time illustrated resourcefulness of the nurse subjects to adjust. Eight subjects specifically commented on the weight as being a problem, yet 5 of the 8 simply determined a way to deal with it (e.g., pulling up a bedside table, putting it on the edge of the bassinette, balancing it on a side rail or bedside table, or propping it on their knee). This also spawned the request for a strap or somewhere to hang the device when hands were needed for something else.

4.3.3. Theme 3: Security and Safety. The theme of "security/safety" is a compilation of specific items in the consolidated data set that relate to the perceptions of security and safety aspects of the C5 device. The concept of ability to disinfect the C5 was included in this construct as a patient safety dimension.

Participants rated the ability to disinfect the C5 as a "very important" feature ($N = 13$) and as making an important contribution to ease of use and efficiency. Regarding theft and data security, six of 15 leaned more towards "very worried," while 7 were on the opposite end of "not very worried." The survey results also revealed that most of the subjects were not concerned about the security of patient data on the C5, with thirteen of the 15 subjects having "little to no concerns." In the transcripts, two subjects voiced concerns that patient data "lives" on the C5 even after being explained that the C5 is just a conduit to the server. These two subjects were adamant, fearing that if the device was stolen someone could access a copy of patient data that resides inside of the C5. Six of the subjects expressed concern that the C5 would be appealing to thieves and also that the clinicians would be held responsible if the device were stolen.

4.3.4. Theme 4: Efficiency Gains. The theme of "efficiency gains" is a compilation of variables from the consolidated data set that relate to the potential contributions that the C5 device may make to efficiency and usefulness. The process of wipe disinfecting the device clustered with this construct due to comments about time savings and/or additional steps that may facilitate efficiency in workflow.

The overall usefulness of the device was rated highly positive on the survey, with 13 subjects indicating that the C5 would help improve their practice. The transcripts and observational data support the survey data. Comments included "No more running back and forth, forgetting and missing details. I have the machine where I need it and when I need it" and "In the morning, we have so many services on the floor, everyone is looking up their labs, and all the computers are taken up and nurses cannot get to their POE orders because they cannot get to the computer. This will allow them to have their own POE orders in their hands, and

not have to worry about fighting a resident for a computer system first thing in the morning."

Similarly, 13 of the 15 subjects on survey believed that the C5 will improve their efficiency and effectiveness. The transcript and observational data support the survey data. Comments included "The disadvantage (of) coming out to the station is that you always get interrupted and then you (find that you) forgot to document, whatever. So the faster you can document, related to the actual care is better. So I think the closer to care is good" and "not walking back and forth to the nurse's station saves me time and steps. I do not have the enough energy or the memory to waste anymore."

4.3.5. Theme 5: General Ease/Intuitiveness. The theme of "general ease/intuitiveness" is derived from the variables that relate to the overall ease of using the device and the ability to "figure out" how to do something with the C5 relying on intuition and experience.

On the survey question of "overall impression of the C5 device," the majority of the participants rated the C5 device highly. Eleven subjects rated the C5 as a "4" (approaching "wonderful"), and "4" ranked it with a "5" (wonderful). On the survey scale that assessed frustration versus satisfaction—8 of the subjects felt that the device was frustrating (8 ranked it as neutral or worse) to use. Similarly, 7 of the 15 rated the device as somewhat difficult to use. However, ten of the fifteen ranked the use of the device as stimulating or very stimulating (in contrast to boring or dull) to use. Most of the subjects (9) rated the C5 as "intuitive and easy to use."

The results of the observation data shed additional light on the seemingly contradictory findings from the survey. Those who had an observed higher level of computer experience appeared to be more "at ease" with the device and used the features much more easily. This observation may illustrate differences between self-rated levels of computing experience (which were high by survey) with actual ability. For example, even though the majority of survey results pointed towards high level of comfort and computing literacy, subjects who were familiar with the TIP tool were observed to readily use it without issue. Those subjects who were very familiar with Eclipsys SCM 4.5 software had apparent/observed higher levels of comfort. Subjects with a greater degree of computing experience were able to open and close applications easier, use the barcode scanner, increase sizes of windows to enhance visibility, and readjust the view (portrait/landscape) to adapt to needs. Others struggled with certain aspects of the device and their frustration was apparent to the observers. Examples of comments from the transcripts were "Do something with the string, it is driving me crazy"; "I can do this quicker with a pen and paper, the handwriting recognition is not working for me"; "How do you minimize something. . .actually, what does minimize mean?"

5. Discussion

On the whole, the study participants perceived the C5 as highly useful, believed that the device would contribute to efficiency gains in practice, and considered device portability to be very important in supporting clinical workflow. The subjects' comparisons of the C5 with standard and current personal practice revealed significant frustration with the redundancy of current methods of documentation, device overload, and the imperative of employing workarounds when inefficient processes impede timely completion of tasks in busy environments.

The ability to quickly disinfect the device and move on to the next patient was clearly important to the nurses who were the subjects in the study, particularly in consideration of an increased focus on prevention of hospital acquired infections. Compared with current methods for documentation and performance of the tasks the C5 supports, the subjects valued the ability to untether from the nurse's station and be able to access and enter data instantaneously at the point of need. In addition, the value of having a personalized portable computing device and not having to compete for a workstation, particularly during shift change or rounds, was a virtue of the C5 raised by subjects. Barcoded functions are increasing in popularity, and the subjects expressed strong desire for not being loaded with another device or having to pull a computer on wheels with an attached barcode scanner into the room. Smaller, more portable, and all in one appeared to be the most desirable mechanism for this study population.

The untethering potential of the C5 may have implications beyond ubiquitous access to data. Empowered by a portable multifunction device, clinicians began to imagine novel ways the technology could be used to help them in their daily work. Several of the subjects who specialize in ostomy and wound care began to generate ideas about exchanging wound pictures across the team to measure healing responses, to be able to take a picture of a sacral ulcer to show a patient the impact of a certain treatment or the benefits of an action the patient and or family has taken, or to take a picture of a patient as part of the formal medical record so that proper patient identification at bedside is enhanced. Digital photography incorporated as part of wound care assessments was viewed by several of the participants as a more accurate method of documentation than the current practice of narrative description.

Even in light of the overall positive reaction to the concept of an all-in-one portable computing device, distinct usability issues emerged from the study. Some of the identified usability issues were potentially serious and could have negative consequences, from user frustration and possible technology abandonment, to patient harm. The study revealed many aspects of the device that could be improved with design modification and also perhaps through enhancing training and increasing computer literacy in clinical user groups [11]. The aspects of the device most in need of attention, in the view of study subjects, were centered on "form factor" or physical device form. The areas of improvement in regards to the form factor included:

(1) the location of on/off switches next to other important feature buttons. Frustration was high when, after arranging the patient and the device to take a picture,

the off switch was accidentally pressed instead of the shutter and the machine shut down. It took considerable time to restart and reauthenticate, reposition the patient and refocus, generating negative subject reactions;

(2) the location of the stylus tether which results in its hanging over the camera lens. After taking a sometimes difficult to obtain picture, users were quite frustrated with the appearance of the tether;

(3) the weight of the device without some way to offload it easily to reduce weight stress and/or free up hands. As the study procedure time progressed, subjects began to voice concerns about the weight and what 8 or more hours of use would invoke;

(4) the camera structure with no auto focus or ability to adjust lens without moving the device and the low megapixels of the camera. The manner of focusing (similar to that of an i-Pad) was not positively received, and the low resolution thwarted some of the benefit of wound documentation where edges and color resolution are very important aspects;

(5) the need for detachable/retractable components to better support workflow, such as the camera and the barcode scanner on a tether to support higher maneuverability around a patient. Subjects suggested that a camera lens or the barcode reader be put in the stylus (or similar) so that they could stretch it to the patient instead of requiring the movement of the entire device to the patient.

Other areas of improvement were noted that are not related to the physical form factor, and fell instead on aspects related to the subjects themselves. Approximately half of the subjects had concerns about the security of patient data on a portable device, a view that persisted after discussions of how client-server technology eliminates persistent data storage on the C5. The subjects' belief about data persistence was difficult to change. An additional aspect was in the observed difference between self-reported computer comfortableness/literacy and the observed levels of the same. Even though the demographics in the survey illustrated that all but 2 of the subjects felt "very comfortable" with computing technology and that over 50% said that they routinely use computing technology in the workplace, there were observable differences in comfort and agility of use of the device. Nurses who were observed to be more comfortable with computing technology had lower levels of frustration, and more easily configured the device to fit their style. Several subjects struggled with basic computing manipulations such as minimization, how to work with pull down menus, and moving between landscape, and portrait orientations. The findings point to a need to enhance the general computing competencies of all clinicians—who are expected to be able to work with increasingly complex health IT.

An additional potentially valuable outcome of this study in a specific example of health IT usability is in the five themes that emerged from the multimethod approach. With the expectation that more devices of this type will come on the market with similar design characteristics, a structure for quickly assessing the general dimensions of usability may be a useful tool. Further study and validation is needed, however, particularly in naturalistic settings where additional external influences will further impact use patterns and potential workarounds.

The primary limitation of the study is the focus on a single device with multiple features that have been encapsulated in a specific form factor. As such, the results speak to the usability of this single device in toto. While many of the findings may carry forth to support general usability principles (e.g., the suboptimal placement of the on and off button adjacent to the shutter button), this study was not able to measure the contributions of individual features to overall measures of usability.

Finally, generalizability of the usability themes that emerged from this work must necessarily be the subject of further research. These themes may prove to be limited to multifunction devices such as the C5 or they may generalize more widely. Further research that focuses upon consolidated devices such as the C5 and their impact on usability is warranted.

In general, the study resulted in overall positive findings regarding the utility and usability of a portable information appliance, particularly in comparison to current methods used by the participants in similar clinical situations. The usability constraints that arose were primarily related to the physical form factor, issues that can be mitigated with further design modification. The need for mobile and highly usable devices to support the effectiveness of busy clinicians is high, and further studies of the alignment between design intention and real-world use are imperative.

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Clinical Study

Building the Clinical Bridge to Advance Education, Research, and Practice Excellence

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The University of Michigan School of Nursing and the Health System partnered to develop an undergraduate clinical education model as part of a larger project to advance clinical education, practice, and scholarship with education serving as the clinical bridge that anchors all three areas. The clinical model includes clusters of clinical units as the clinical home for four years of a student's education, clinical instruction through team mentorship, clinical immersion, special skills preparation, and student portfolio. The model was examined during a one-year pilot with junior students. Stakeholders were largely positive. Findings showed that Clinical Faculty engaged in more role modeling of teaching strategies as Mentors assumed more direct teaching used more clinical reasoning strategies. Students reported increased confidence and competence in clinical care by being integrated into the team and the Mentor's assignment. Two new full time faculty roles in the Health System support education, practice, and research.

1. Introduction

Over the past several years, schools of nursing have been called upon to restructure education programs to better prepare graduates for increasingly complex and rapidly changing health care environments [1–3]. According to Benner and associates [2], nursing education programs must be redesigned to prepare nurses for new responsibilities and challenges in these health care environments. To accomplish this, the practice-education gap must be addressed by major shifts in both curricula and teaching methods [2]. The call to revise nursing education programs is paralleled by similar calls from other organizations including the Robert Wood Johnson Foundation (RWJF) [4] and the Institute of Medicine (IOM) [5]. The Institute of Medicine's 2001 report, *Crossing the Quality Chasm: A New Health System for the 21st Century,* recommended that leaders in health professions should develop strategies for "restructuring clinical education to be consistent with the principles of the 21st-century health system throughout the continuum of undergraduate, graduate, and continuing education for medical, nursing, and other professional training programs" (Recommendation 12, p. 208). The recent consensus report of the RWJF in collaboration with the IOM, "Initiative on the Future of Nursing: Leading Change, Advancing Health" [6], emphasizes that nurses should achieve higher levels of education and training through an improved education system that promotes seamless academic progression.

Recently, partnerships between schools of nursing and service settings in hospitals and other health care agencies led

to the development of new approaches to improve clinical learning. The goal of these partnerships is to facilitate students' understanding of both the responsibilities of the nurse and the environments in which nurses work as they acquire clinical knowledge and proficiency necessary for competent practice. One common approach in hospital settings is the Dedicated Education Unit (DEU). Pioneered in Australia [7], DEUs are health care units either enhanced or developed through partnered commitments by clinical faculty and nursing staff to enrich student nursing clinical education. To help students complete learning objectives, an environment is created to provide optimal learning opportunities using a variety of teaching and learning strategies [7–13]. In the DEU model, education responsibilities may not be shared equally between the clinical faculty and clinical nursing staff. While clinical faculty are present to assist with student learning and model good teaching practices, the clinical staff assumes more responsibility for direct instruction of students assigned to them. Typically, the number of DEUs in any health care setting is small. Thus, not all students experience this educational concept during their program of study in nursing. Those not participating receive the more traditional model where the clinical faculty assumes nearly all responsibility for clinical instruction with less intensive involvement of staff nurses. In the traditional approach, clinical faculty and students often are viewed as "guests" on the units that host students as neither the faculty or students are fully integrated into unit functioning.

Outcomes of the DEU concept of clinical education for undergraduate nursing students are not extensive, and the concept continues to be explored. Extant findings [9, 10, 12, 13] document positive outcomes to this approach in clinical education. Collectively, outcomes show that students report feeling welcomed and supported by nursing staff, and included as members of the health team. They express confidence in patient assessment and communication skills and report taking greater responsibility for their own learning. Clinical nursing staff comment that students are more accountable for patient care than traditional model student. Clinical staff report they are comfortable that the quality of care is upheld in the new approach and are pleased to see that students are advancing clinically. In addition, clinical staff members report that they became more aware of the curriculum and clinical education requirements.

In 2007, the University of Michigan School of Nursing (UMSN) and nursing services at the University of Michigan Health System (UMHS) formed a partnership called The Initiative for Excellence in Clinical Education, Scholarship and Practice. The partnership was designed to leverage the resources and expertise of both organizations to advance all three mission areas.

To begin the work, the partnership engaged in an extensive change process using Danemiller Tyson Associates' Whole-Scale Change [14]. Whole-Scale change is large organizational change that occurs through the power of microcosms, groups comprised of members who represent and bring a perspective of every level and area of their organization, and nonmembers who represent those who rely on their organization to meet their needs. The assumption is that these stakeholders collectively have knowledge of the work of the whole system and their wisdom can bring about a new identity for how the organization will function in the future. For our two partnering organizations, stakeholders ($n = 120$) included members from all levels of staff nurses and nurse administrators, all levels of faculty including administrators and graduate student nursing instructors, nursing and medical students, physicians, patients, financial and human resource representation, and the vice-chair of the nurses' collective bargaining unit at UMHS. At a two-day retreat called an Event [14], stakeholders were placed in small groups and asked to define the current state of our working relationship with respect to clinical education, practice, and scholarship, to envision a different future state for our relationship in these mission areas and to propose actions to move toward the future state. A facilitator skilled in conducting Whole-Scale change guided the work of participants. From the considerable data generated throughout discussions, six major themes emerged: Teams, Innovative Strategies, Shared Vision, Physical Facilities, Human Resource Development, and Outcomes. A six-member Task Force with representation from both organizations was charged to elaborate each theme with actions culled from the larger dataset generated at the Event. These themes and actions subsequently would serve as the foundation for further work on each of the three mission areas—clinical education, practice, and scholarship.

Developing a clinical education model became the first priority for our work. By embedding students in the clinical setting with faculty who have clinical and research expertise education becomes the clinical bridge that anchors and connects all three mission areas. This link is critical both to advancing practice and solving clinical problems to improve patient outcomes. The purpose of this article is to describe the first phase of our collaboration, the development of the Clinical Education Model, with attention given to the recommendations put forward by the IOM, RWJF, and others.

2. The Clinical Education Model

A three-member Project Team consisting of two faculty from the UMSN and one Health System nursing director was charged to use the themes from the Event to develop a new clinical education model that was vetted and ready for pilot implementation in one year. In developing the new model, it was explicitly stated that the proposed model must align with values and goals of each organization and with current economic resources, that existing contractual and other legal and regulatory requirements must be honored, and that the model must align with the current undergraduate course curriculum. In addition, the new model was to reflect recommendations of organizations calling for change in how nurses were educated in order to better prepare them for current health care environments. An Advisory Committee to the Project Team was formed comprised of members from both organizations including the Dean, the CNO of the Health System, and students. The role of the

Advisory Committee was to provide advice, consultation, feedback, and recommendations throughout development of the model and plan for pilot implementation.

That this is a true partnership between our organizations was demonstrated as the Project Team consulted with various faculty, students, and clinical partners in the Health System including Clinical Nurse Specialists, Educational Nurse Coordinators, Supervisors, and staff nurses for suggestions and endorsement throughout development of the model. Feedback from these stakeholders was instrumental in revising ongoing work. Circling back allowed stakeholders to see how their suggestions and concerns were handled. This approach to the work also permitted participants in the process to develop relationships over time and increase knowledge of Health System units, patient populations, nursing practice, student instruction, and the curriculum. Over the year of model development, 18 presentations and interactive sessions were held with various stakeholder groups. Final vetting occurred with both organizations including the nurses' collective bargaining unit in the Health System. The new model consists of five components: Clinical Unit Clusters, Clinical Teams, Student Skill Development, Clinical Immersion, and Student Portfolio.

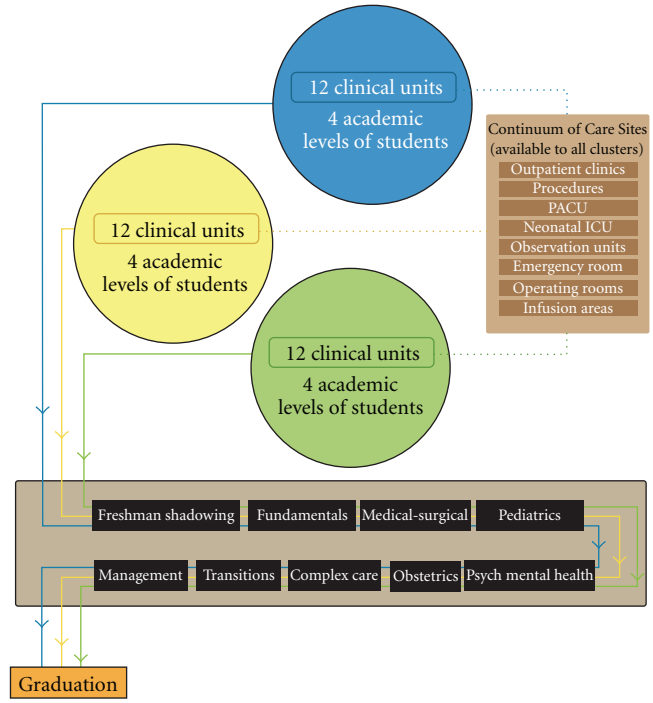


Figure 1: Clinical clusters, continuum of care, undergraduate clinical courses.

2.1. Clinical Unit Clusters. Maximizing UMSN student placement capacity at UMHS was highly desired as the environment provides strong evidence-based practice and quality of care is paramount. At the time of model development, many UMSN students received clinical education in multiple hospitals and agencies. In the new model at UMHS, all 36 inpatient clinical units, comprised of adult acute care, pediatrics, ICUs, and specialty services, were used to construct three multiunit clusters (see Figure 1) comprising key components of students' clinical requirements. Each cluster (Blue, Yellow, Green) includes students of all academic levels. Students organized in these clusters progress through undergraduate clinical courses over their four years of study. Continuums of Care areas available to all clusters are clinical areas in addition to inpatient units that provide care and services to patients as needed. Maximizing the use of these additional clinical areas affords students opportunities to participate in and follow patient care throughout the health system as they learn about nurses' roles in a variety of settings and reduces the need for placements at external agencies. In the current model, a few sections of obstetrical nursing and psychiatric nursing continue to be external due to current limited capacity of these services at UMHS. Community Health Nursing continues to be community based.

Upon admission to the School of Nursing in the freshman year, students are assigned to one cluster and will have diverse clinical experience designed to meet all clinical course objectives across the four years of the curriculum. Students who transfer from community colleges at the junior level are entered into clusters when admitted. The assignment to clusters familiarizes students with a defined set of units, their operations, and the work of nurses as the context for clinical learning [2]. In addition, the clinical cluster approach creates cluster identity among faculty, staff, and students thereby enhancing relationships among these individuals in such a way that both education and patient care can benefit. Cluster unit familiarity has high potential to increase identification of clinical problems for further study both within and across units in the cluster. Health System Clinical Unit Profiles, descriptions of each clinical unit that include common patient populations, diagnoses, medications, and treatments, are given to students for each unit in their cluster. Profiles provide background information which orients students to the cluster of units to which they are assigned.

2.2. Clinical Team. In the model, a clinical team (see Table 1) is the relational structure between faculty, Clinical Mentor, Clinical Resources, and students in which clinical education of the students occurs. Five roles are described for each Clinical Team: (1) Faculty of Record, (2) Clinical Faculty, (3) Clinical Resources, comprised of current unit-based clinical leaders known as Clinical Nurse Manager, Clinical Nurse Supervisor, Clinical Nurse Specialist, and Educational Nurse Coordinator who serve as sources of information about patient care issues on an on-need basis, (4) Clinical Mentor, and (5) Student whose responsibility is to work closely with the Clinical Mentor and Clinical Faculty in providing patient care while progressing in a learning environment. Students are involved in the Mentor's entire patient assignment over the course of the shift. Thus, the student is an integral team member and not a "guest" in the patient care environment [2]. Table 1 provides role descriptions.

All members of a clinical team are expected to develop strong relationships and function as an integrated group

Table 1: Clinical team teaching roles.

Team member	Role description
Faculty of record	Member who facilitates the delivery of course materials and translates course requirements to the Clinical Team in addition to other responsibilities associated with the didactic portion of the course
Clinical faculty	Member who oversees delivery of the clinical practice experience for students to meet clinical course objectives
Clinical resource	Unit nursing leadership member who supports learning at the point of service through integration of faculty and students into unit operations
Clinical Mentor	Staff nurse at UMHS who, consistent with scope of practice of the Registered Nurse, models the professional nurse role and participates in the clinical education of students
Student	U of M nursing student who participates fully in clinical care through integrated membership in the clinical team, engages in the educational activities designed to achieve course outcomes and to build the foundation for nursing practice, and contributes to patient care using the skills for which the student has been determined competent

rather than through a hierarchical structure of accountability. Clinical Faculty are matched as much as possible where their clinical skills and knowledge are compatible with unit patient populations as they are responsible not only for clinical education but for participation in scholarship and practice development on these units as well. They may provide direct instruction of the student but are more likely to facilitate the student's learning through work with the Clinical Mentors. Importantly, they model appropriate teaching strategies, clinical expert practice, and an understanding of evidence-based practice and its application. The Clinical Mentor assumes a direct role in student education while using Clinical Faculty for guidance in conducting the student's experience.

Figure 2(a) shows the relational patterns among all members of the team. Figure 2(b) reflects a shift in teaching responsibility as Clinical Mentors work closely with students while they engage in clinical care. Figure 2(c) shows the direct role that Clinical Faculty bring to the partnership including oversight of student assignment and some direct instruction of the student, modeling teaching strategies to the Mentor, ensuring that course objectives are being met, and participating with the Mentor in assessing student performance. These figures demonstrate, at the unit level, the partnership that was envisioned at the Whole-Scale Change event.

In addition to preparation for the role of Clinical Mentor, a document developed by nursing staff and clinical unit leaders, with added input from the Project Team, specifies essential characteristics guiding the transition into the Mentor's new responsibilities. This document charts the growing responsibilities of Mentors as they mature in the role. Members of the clinical team together provide a rich environment in which to nurture and support student growth in clinical competence.

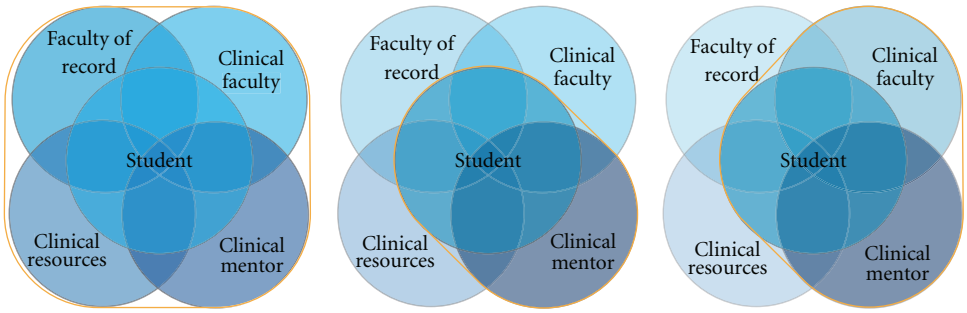
2.3. Student Skill Development. In reframing the student's role as a team member, new approaches were needed for skill preparation for clinical courses. Faculty were aware from prior nursing staff feedback that increased skill preparation for students was necessary for successful student integration into the clinical team. Following an intensive workshop for faculty and clinical partners on simulation use in student education, new simulations were designed and embedded in clinical courses to improve clinical reasoning in the delivery of patient care. Planned laboratory time provides for practice and evaluation of student competence in relevant skills. Successful completion increases the students' ability to participate in patient care as an integral member of the clinical team.

2.4. Clinical Immersion. Increasing the number of hours devoted to clinical practice is important for gaining competence and feeling confident in providing care. Over time, nursing curricula have included more didactic content and fewer clinical hours. In addition, student clinical assignments often have been limited to the care of one or two patients not only early in clinical experience but throughout the entire curriculum [2]. Current clinical environments demand that the nurse be able to manage a larger assignment while providing exemplary evidence-based care. The clinical model incorporates intensive clinical experiences in which students are fully engaged in a practice environment providing care to patients and families.

2.5. Portfolio. A paper portfolio consisting of course descriptions, Clinical Unit Profiles, Student Skills Checklists for both completed skills and those to be achieved, and Midterm and Final Student Clinical Evaluation Forms is given to students. A Clinical Mentor Feedback Form to serve as a communication tool between the Mentor and student about the student's performance and to provide written documentation for Clinical Faculty is also included. Clinical course materials for subsequent courses are added as the student progresses in the curriculum. The portfolio is designed to be utilized by all Clinical Team members to facilitate student learning and performance. Transition to an electronic portfolio is to be determined by the patterns of use, value of current materials, and compatibility with UMHS systems.

3. The Clinical Pilot

The clinical education model was pilot tested in the junior year of the generic undergraduate program from September, 2008 through April, 2009 when the academic term ended. Since it was not reasonable at the outset to test the model



(a) Clinical team (b) Direct patient care responsibilities (c) Shared responsibilities for clinical education and evaluation

Figure 2: Clinical team.

for all four years of the curriculum, the decision was that the pilot would include only students in the junior year when they were enrolled in specialty clinical courses.

Half the students ($n = 31$) enrolled concurrently in medical-surgical and pediatric nursing courses participated during the fall term pilot. They continued in the pilot during the winter term when enrolled in psychiatric and obstetrical nursing courses. An additional 30 students who completed the psychiatric and obstetrical nursing courses in the fall joined the pilot for the first time in the winter term for a one-term pilot experience. By the end of the winter term, half the junior class ($n = 61$) had experience in the new clinical education model. The selection of clinical units to participate in the pilot was decided following conversation with unit leaders and staff. The decision was that highly enthusiastic units would be asked to participate as the likelihood for demonstrating success of the clinical model would occur with units that were more positive about change and willing to work to enhance the success of our partnership. In the fall term pilot, three medical-surgical units and one large pediatric unit participated. During the winter term, the large women's birthing unit and one adult and one child psychiatric unit were added. All units were in the Blue Cluster.

Orientation and training to the model and the operation of its components was developed for all pilot participants including clinical leaders, staff who would become Clinical Mentors, Clinical Faculty, and pilot students. Each session was three hours. Introductory time was allotted to meet each other and hear the vision of the new partnership from the Dean and the CNO. Planned exercises were designed to prepare participants to successfully inhabit new roles and responsibilities, and to increase understanding of communication strategies in the patient care settings. To create an identity for The Initiative, a logo and color scheme was designed and used for all materials posted in common areas, distributed materials, presentations, and portfolio covers. All Clinical Faculty attending the Orientation and Training had been teaching in the traditional clinical program and would be continuing in the new education model. Nursing leaders and nursing staff who attended had worked previously with students from UMSN.

A series of upfront skills sessions, relevant for the clinical courses in which students were enrolled, was designed and took place during the first month of each semester before clinical experience began (see Table 2). These skills and scenarios were in addition to those covered in the lecture portion of the clinical courses. Faculty and clinicians from UMHS presented material and demonstrated skills including use of high-fidelity mannequins. Skills sessions were accompanied by scenarios of clinical events that could occur in patient care areas that required intervention. Practice opportunities for students followed and included practice of the skill as well as clinical reasoning exercises to support decisions made during skill demonstration. Materials were made available for student use during and following demonstration. During this month, students attended class lectures and completed course assignments. Their clinical experience on the units began in the fifth week of the term. They were paired with a unit Clinical Mentor and began their role as a member of the Clinical Team.

The clinical immersion experience (Table 2) consisted of two consecutive days per week alternating clinical specialties each week (i.e., medical-surgical nursing the first week and pediatric nursing the second) for five weeks followed by three weeks of four consecutive clinical days. The remaining week of the term reverted back to a two-day experience to accommodate the academic calendar. In Winter term, the same plan was followed for ongoing pilot students now enrolled in obstetrical and psychiatric nursing. New students to the pilot in Winter term followed the same clinical schedule as their peers in Fall term. The immersion was intended to actively engage students in clinical work, to increase competence, and to enhance their understanding of the nurse's role in managing holistic change in patients over time. Students were expected to be fully involved in the Mentor's entire patient assignment over the course of the shift. Pilot students used the clinical portfolio to guide clinical work and collaborate with Mentors on assessment of performance.

Pilot and nonpilot students were together for the didactic portion of each of the clinical courses. Aside from shared class attendance nonpilot junior students followed the traditional model of clinical education. They began their clinical

Table 2: Students clinical immersion schedule.

Week	1	2	3	4	5	6	7	8	9	10^	11^^	12	13	14
Days	0*	0	0	0	MT	**	MT	MT	MT	MT	MT/WTh	MT/WTh	MT/WTh	MT
Course(s)	0	0	0	0	P°		MS°	P	MS	P	MS/P	MS/P	MS/P	MS
	0	0	0	0	MS		P	MS	P	MS	P/MS	P/MS	P/MS	P

Legend: ^: classes completed week 10. ^^: week 11 the 4 day clinical immersion. *: no clinical/class day only. **: MT study break no clinical/class held. °: Pediatrics or medical/surgical nursing.

experiences at the start of the term and did not participate in the upfront skills sessions. They followed the typical student plan for clinical experiences of two days per week alternating clinical specialties each day (i.e., medical-surgical nursing the first day and pediatric nursing the second) across the entire term. The Clinical Faculty member on the unit was largely responsible for selecting patient assignments, monitoring student performance, and assessing performance. Nonpilot students were not part of a clinical team, and they did not use a student portfolio. Clinical Faculty solicited input from staff about students' performance and provided this feedback to students and used it as needed in written evaluations.

Throughout the pilot of the clinical model, Project Team members visited clinical units to monitor the learning environment. Discussion occurred with Clinical Faculty, Mentors, and students to solve problems, answer questions about team functions, or work one on one with team members to support their respective roles in the Clinical Team. Occasionally, clinical unit meetings were held to further explain the model and respond to questions.

4. Evaluation Methods

Clinical Faculty, Clinical Mentors, Clinical Resources, and pilot students participated in clinical model evaluation. Nonpilot (Traditional students) were not asked about their experiences in the traditional model or their thoughts about how not having the pilot opportunity influenced their perception of their education.

Feedback regarding the clinical cluster arrangement was gathered during meetings of unit representatives from each cluster group—Clinical Resources, Mentors, and Clinical Faculty. Clinical Cluster meetings were typically held twice a year, once per term, for discussion and confirmation of upcoming clinical placements. Data from two discussion sessions with Clinical Faculty, Clinical Leaders, and Clinical Mentors ($N = 23$, Fall and 25 participants Winter) constituted the method for data collection during and following the pilot. On average, representation was approximately 4 representatives from each pilot unit including the Clinical Faculty member. The number of attendees per unit attending the discussions is acceptable given that time away from the unit needed to be negotiated in advance to cover staffing and students. Prior to the discussion sessions, attendees talked with others on their respective units to gather information in order to bring as many perspectives as possible to the discussions. Components of the clinical education model—Clinical Teams, student skills preparation, clinical immersion, and student portfolio guided discussions.

Focus groups with pilot students were designed to elicit information about each of the components of the clinical mode. Feedback was obtained at term's end ($N = 25$) for the Fall term pilot students (Medical-Surgical/Pediatric courses) and at the end of the Winter term from this same group of students ($N = 25$) now enrolled in Obstetrical/Psychiatric Nursing courses. Feedback from the one-term Winter pilot students ($N = 24$) in Medical-Surgical/Pediatric Nursing courses was also obtained at the end of the term. The one-hour focus groups were led by a skilled facilitator who was unknown to the students thus reducing worry about being candid. Faculty were not present in order to maintain an unbiased and nonthreatening environment. This number exceeds that typically recommended for sessions [15] but did not restrict students from expressing, concurring, or differing with views expressed by peers. The facilitator summarized information after each discussion of a clinical model component to clarify that the information was an accurate representation of views. Changes to the information were based on student input and agreement. Each session was taped, session notes were taken by a recorder, and a summary report was generated by the facilitator.

5. Key Findings

5.1. Clinical Clusters. The clinical cluster concept for student education was new to faculty and clinical staff. These members supported the concept of clinical clusters and agreed to continue defining working relationships both within and across clusters. One immediate and very positive outcome of work across clusters was a more efficient clinical placement process of UMSN students.

5.2. Clinical Teams. During discussion sessions, faculty described needing to adjust their role from full responsibility for student education to shared responsibility with Mentors. This change required modeling best education practices as well as facilitating Mentors in their new role in the clinical team. Faculty also reported that their working relationships with unit nurses improved. Initially, some Mentors were tentative about their new role and engaged students less fully in the team (see Table 3) until, with faculty and unit leadership support, their comfort level increased. The experience level of Mentor seemed not to affect ability to function in the role. Clinical Faculty and Clinical Mentors both indicated that students benefitted from being a member of a clinical team and they soon adjusted to their new role in the team. Mentors, in conversations with faculty reported using more clinical reasoning strategies with students, and

Table 3: Pilot faculty and clinical staff discussion group comments.

Fall Term 2008 (Medical Surgical and Pediatric Courses) $N = 23$
Clinical Teams
(i) RN staff varies in ability to function in Clinical Mentor role regardless of attending orientation or training
(ii) Over the term positive relationships developed between students and Clinical Mentors
(iii) If choice needs to be made between student continuity with a patient or a Clinical Mentor, a consistent patient assignment was preferred
(iv) Adjustment to new collaborative role was achieved and viewed positively
Skills Preparation
(i) Skills sessions did not make an appreciable difference in students transition to clinical practice
(ii) More direct unit based skills training and evaluation of student competency needed
(iii) Expectations of student clinical performance should be consistent between Faculty and Clinical Mentors
Clinical Immersion
(i) By terms end, two consecutive days of clinical practice was viewed as a strength
(ii) Advantage of 4 day clinical immersion was found in time-management skills and continuity of patient care
(iii) Compressed class time seen as tiring for students
Portfolio: Clinical Mentor Clinical Feedback Form
(i) Portfolio became useful once student had more clinical experience
(ii) Clinical Mentors were inclined to rate students highly while not addressing areas for improvement
(iii) Written comments were more helpful then rating scale based evaluation
Winter 2009 (Medical Surgical, Pediatric, Obstetric and Psych Courses) $N = 25$
Clinical Teams
(i) New RN's were seen as strong collaborators with students and Faculty.
(ii) Clinical Mentor confidence in their own abilities improved over course of term
(iii) Some concern regarding slower identification of lower functioning students when paired with multiple Clinical Mentors. Consistency of pairing a priority for some students
Skills Preparation
(i) Faculty as well as students need to be knowledgeable of unit based clinical skills
(ii) How to give and receive shift report identified as a valuable skill for students to learn
Clinical Immersion
(i) Units with highly complex patient populations experience Clinical Mentor and student fatigue
(ii) Collaborating with Clinical Mentor on full patient assignment improved student confidence
Portfolio: Clinical Mentor Clinical Feedback Form
(i) Training in how to give and receive feedback needed for both Clinical Mentors and students
(ii) Clinical Mentors need support of Faculty to openly discuss expectations with students
(iii) Students need encouragement to converse with Clinical Mentors about expectations and performance
(iv) Clinical Mentor feedback form requires revision to capture more dynamic and useful feedback of student performance

those who had worked with UMSN students previously indicated it was their impression that students' clinical performance was accelerated beyond previous cohorts of students. Mentors commented that their own practices were enhanced by the new clinical education model.

Focus group discussions with students (see Table 4) revealed that they enjoyed working in the clinical team and most became fully integrated over the term. Being fully integrated, according to students, meant that they were involved in all aspects of their Mentor's assignment. Students agreed that through experience as a team member they became more skillful in organizing work, communicating with others, practicing with greater independence, and identifying and requesting learning opportunities. Students also reported that they benefitted from frequent feedback from Mentors during the day about how the day's work was progressing. They acknowledged that some Mentors were less eager to include students in their assignments.

5.3. Skills Preparation. Overall, the upfront presentation of clinical skills did not fare as well as expected. Both Clinical Faculty and Mentors agreed that skill preparation should be increased throughout the curriculum with unit-based skills emphasized during clinical conference time on the unit. Mentors added that being able to receive and give report to others at shift changes is an essential skill to be included. Students maintained during focus group discussions that time were not used well, sessions were long

Table 4: Pilot student focus group comments.

Fall 2008 (Medical Surgical and Pediatric Courses) $N = 25$
Clinical Teams
(i) Described themselves as fully integrated into team over the term
(ii) Increasingly communicated with health care provider
(iii) Better understanding of the roles of Clinical Resources
Skills Preparation
(i) Skills preparation less than useful
(ii) Requested more unit-based skills
Clinical Immersion
(i) Increasingly more comfortable and confident in clinical practice
(ii) Continuity in clinical care was seen as a plus and team relationships grew
Portfolio: Clinical Mentor Clinical Feedback Form
(i) Further orientation and training required to achieve full benefit of portfolio use
(ii) Written comments perceived to have more value than ratings scale
Winter 2009 (Medical Surgical, Pediatric, Obstetric and Psych Courses) $N = 49$
Clinical Teams
(i) Experienced Mentors were perceived as more comfortable in the role of clinical educator and with integrating students into the clinical team
(ii) Practiced over the term with greater independence
(iii) Mentor feedback beneficial, post care debriefing sessions viewed positively
(iv) Some RNs less willing to engage students in clinical practice
Skills Preparation
(i) Skill learning/performance increased when skills tied to unit based clinical practice
(ii) Skills reenforced when unit based scenarios used in clinical conference
Clinical Immersion
(i) Provided realistic look at life as a nurse
(ii) Improved patient relationships and understanding of experience from patients' perspectives
(iii) Being proactive in seeking opportunities added a positive effect on overall experience
Portfolio: Clinical Mentor Clinical Feedback Form
(i) Recommended defined comment section on student performance, that is, safety, clinical skills, communication
(ii) Mentor familiarity and preparedness affecting value of feedback
(iii) Student involvement in evaluation increased understanding of clinical performance

and with limited practice, and unit-based skills they felt were necessary were not included. During Winter term, the addition of unit-specific skills to clinical unit orientation and clinical conferences was seen to facilitate learning and skill performance by students, especially when accompanied by clinical scenarios.

5.4. Clinical Immersion. As shown in Table 3, Clinical Faculty and Mentors agreed that two consecutive clinical days and later four consecutive clinical days increased student competence over the term. Toward the end of the term, during the four consecutive clinical day experience, faculty reported in that students' time-management skills increased noticeably from the beginning of the term. They also noticed that students seemed tired from the extended clinical time. Students (see Table 4) reported having a better understanding of patients' experiences and care with increased time and continuity of patient assignments. In addition, they reported their clinical capabilities had increased from the start of the term and patient relationships were strengthened over the course of the immersion experience.

5.5. Portfolio. The utility of the portfolio as a whole was not commented on by Clinical Faculty, Clinical Mentors, or students. However, one document, the Clinical Mentor Feedback Form used jointly by the student and Mentor to assess and summarize the student's clinical day, was singled out and by all groups (Tables 3 and 4). Mentors found the 1–4 rating of student performance hard to use and tended to rate students highly as they were reluctant to use the lower range that might discourage students. They indicated that discussing expectations with faculty about student performance would help with using the scale wisely. Both Clinical Faculty and Mentors agreed that written comments were more informative than the rating scale. Students preferred written comments and recommended

that the form provide more space for these as they are more informative than numerical ratings.

6. Discussion

The vision for a new clinical education model has become a reality and the pilot has shown its potential as well as pointed out areas for improvement. The partnership envisioned by participants in whole scale was demonstrated at every level of model development, in planning for pilot implementation, and in carrying out the pilot. The enthusiasm of units willing to participate in the pilot ensured that every effort would be placed in making the model work. Findings from the pilot revealed the components of the model that were working well and those that required additional effort. Clustering students in a designated set of units for the entire curriculum was endorsed. Projected calculations showed that the new centralized student placement process can accommodate student placement in other years of the curriculum aside from the junior year including Freshman (shadowing experience), Sophomore, and Senior students who need or select placements in our health system. The full potential of clusters supporting education of students housed within them, and in promoting clinical research, continues to be developed.

The clinical team approach to educating UMSN students is new. The traditional faculty role of primary supervision of students changed to that of facilitating and supporting the Mentor who, in turn, took greater responsibility for student learning. Some faculty, early on, were not convinced that this shift in responsibility was appropriate. However, as they participated in the clinical team, they adapted to the new role that included an increase in role-modeling instructional strategies and support for Mentor activities. Clinical Mentors varied in how quickly they accommodated to their revised role in student education, most assumed the new role fairly quickly and easily. Annoyance was expressed by some Mentors who indicated that education of students took too much time and tended to be a burden. With support from unit leadership, the Project Team, and faculty, most became experienced team members. In our model students, as part of a designated clinical team, participate in the Mentor's entire assignment. The relationship among team members provides a rich environment for student learning. Students in the pilot stated that clinical experiences enhanced their learning and that working with the Mentor and other unit leaders gave them a strong sense of contributing to the work of the team while learning. Additional support that the team approach to clinical education worked is that our findings were similar to those found using the DEU. For example, students in our model, like those in the DEU approach, felt they were included in the clinical team, supported by Mentors, more confident in providing patient care and able to assume more responsibility for their own learning [9, 10, 12, 13].

The clinical immersion was rated highly by students. They benefitted from continuity of patient care, became more confident of their capabilities, and began to experience more fully the work of the staff nurse. Student skill preparation has been changed, based on student and faculty input, to include greater emphasis on clinical unit relevant skills in addition to general skills taught in conjunction with courses. Preliminary evidence in the pilot showed that this approach is working.

Although the clinical education model was pilot tested with half of the Junior students, the pilot was not conducted as an experimental study to compare the views and outcomes between pilot and nonpilot students. As a result, nonpilot students were not asked to provide their views about being a student in the traditional program while peers were receiving a different approach to clinical education. Information from nonpilot students may have been useful to understanding their thoughts about the merits of the different approaches, or how being treated differently from their peers influenced their views about the quality of education they were receiving. Comments expressed by nonpilot students in informal venues revealed a mix of responses. Some were angry that they were not asked how things were going for them clinically. Some expressed relief from not having to attend the intense skill preparation sessions or complete the four-day clinical immersion which they stated seemed exhausting for their classmates. Some also mentioned that having fewer clinical obligations at the end of the term left them more time to study. A number commented that they were happy not to be part of an "experiment" and felt comfort in knowing that the traditional curriculum was known to faculty and nurses in UMHS with whom they worked. Although nonpilot student comments may have been informative, they would not have changed the decision to move forward with the new clinical education model. The clinical education model is part of a larger vision of the partnership between the UMSN and UMHS about how we will work together in advancing the missions of excellence in education, research, and practice, with education as the anchor for advancing the other two missions. The new education model is consistent with calls from the IOM and RWJF to restructure education programs to be consistent with 21st century health systems [4, 5], and to prepare nurses for new responsibilities in rapidly changing health care environments [2]. Partnerships and teams are emphasized by these organizations as being critical to improving health care.

Full implementation of the model for all junior students and to all 36 clinical units in UMHS in 2009 followed the pilot. Some changes in the model have occurred. Because it became difficult to structure faculty workload to accommodate both the two-day and four-day clinical immersion over the term, a different approach to clinical immersion was taken. The undergraduate clinical curriculum was revised and approved to add and progressively increase clinical hours from freshman through senior year culminating in a three-day per week capstone clinical practicum over the term supported by seminar. To ensure skill readiness for beginning clinical work, students must be checked off each term on skills they learned in clinical courses the previous term before they can begin the new term's clinical experience. Failure to pass requires repeat testing that may delay the start of clinical work.

Last, and very important, two new clinical track faculty roles are now in place. Clinical Cluster Leads are faculty educators who provide full-time leadership and education to faculty, staff, and students in a cluster. Responsibilities include supporting coordination of clinical placements in the cluster, facilitating faculty in clinical education and practice, and engaging in and leading others in the conduct of clinical research. Clinical Educators are clinical faculty who, in addition to providing supervision and education of students in the clinical setting, will build strong partnerships with Clinical Mentors and through these partnerships conduct scholarly work designed to improve patient outcomes and advance nursing practice. The Clinical Educator now becomes the Clinical Faculty in the model. These two roles require doctoral preparation. Clinical Cluster Leads and Clinical Educators are embedded full time in the clinical setting. These faculty and students comprise the structure of the clinical bridge that anchors and connects the mission areas all three mission areas.

7. Conclusion

The vision for a new clinical education model has become a reality and the partnership between UMSN and the UMHS became stronger as the model was developed and implemented in the Health System. It continues to be a work in progress with the goals of preparing nurses to provide state-of-the-art care to patients and families, adapt to new approaches in rapidly changing health care environments, use evidence to ground practice, and participate in exploring nurse sensitive solutions to clinical problems.

Conflict of Interests

The authors declare no conflict of interest.

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Review Article

Academic-Service Partnerships in Nursing: An Integrative Review

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This integrative review summarizes currently available evidence on academic-service partnerships in the profession of nursing. More than 300 articles, published primarily in refereed journals, were accessed. Articles (110) were included in this review as they presented detailed and substantive information about any aspect of a nursing academic-service partnership. The majority were anecdotal in nature. Topics clustered around the following categories: *pre-requisites for successful partnerships, benefits of partnerships, types of partnerships*, and *workforce development* with its themes of *academic-practice progression* and *educational re-design.* Many examples of partnerships between academic and service settings were thoroughly described and best practices suggested, most often, however, without formal evaluation of outcomes. Nursing leaders in both settings have a long tradition of partnering with very little replicable evidence to support their efforts. It is critical that future initiatives evaluate the effectiveness of these partnerships, not only to ensure quality of patient outcomes but also to maximize efforts at building capacity for tomorrow's workforce.

1. Introduction

In November 2010, the Institute of Medicine (IOM) released its highly anticipated *Report on the Future of Nursing* [1]. This report called for major initiatives to redesign both nursing education and practice to better prepare nurses to lead during health care reform and beyond. In particular, the report outlined the need for increasing baccalaureate prepared nurses to 80% of the workforce, doubling the number of doctorally prepared faculty, removing scope of practice barriers, and disseminating successful collaborative improvement initiatives. Additionally, it recommended implementing nurse residency programs, ensuring that all nurses engage in lifelong learning, preparing and enabling nurses to lead change to advance health, and building an infrastructure for the collection and analysis of interprofessional health care workforce data [1]. It is clear that if we are to achieve these goals, academic and practice leaders must work together. Nurse leaders from both academic and service settings have a long history of collaborating [2–4], but now must do so more effectively and with greater sense of urgency than ever before [5].

A partnership is defined as an arrangement where parties agree to cooperate to advance their mutual interests [6]. In the profession of nursing, academic-service partnerships are most often defined as strategic relationships between educational and clinical practice settings that are established to advance their mutual interests related to practice, education, and research [7]. Although these alliances may be formally arranged, they are more typically informal in nature. More formal and structured relationships have been found to demonstrate greater levels of innovation and effectiveness [8].

Ironically, the twentieth century transition from hospital based training to academically-based nursing education contributed inadvertently but substantially to the development of a wide chasm between academic and service sectors [9]. The melding of nursing education and service dates back to the 17th century when the education of nurses was most often conducted in concert with religious traditions and communities [4]. Partnerships with physicians, medical colleges, and hospitals were the cornerstone of 18th and 19th century nursing education. While contemporary leaders have repeatedly advocated for nursing educators and clinicians to forge new collaborative bonds [2, 3, 5, 7, 10–13], the salience of their call has taken on new urgency in the wake of national health care reform's priorities of affordable quality care and provider accountability. The purpose of this

integrative review of the existing literature on academic-service partnerships in nursing is to provide a foundation for future knowledge development by describing what is currently known about these ventures, and offering an agenda of priorities for moving forward.

2. Methods and Materials

An extensive review of the literature was conducted to synthesize current knowledge about academic-service partnerships in nursing. No other published report on this topic was found. The review included both empirical and conceptual articles published from 1990 through 2010. Data collection consisted of a search of the Cochrane Library, CINAHL, and MEDLINE databases using the following keywords: *nursing, nursing education partnerships, academic-service partnerships, academic-practice partnerships,* and *nursing education redesign*. Consistent with the methodological approach [14], references were also located through journal hand searching and the use of reference lists in retrieved articles. More than 300 articles, published primarily in refereed journals, were accessed. Eligibility criteria for inclusion in the review were English language; publication within the last twenty years; detailed and substantive information about any aspect of a nursing academic-service partnership.

3. Results

More than 300 citations were accessed. Of these, 110 met the criteria for inclusion, only nine of which reported on original research. Many examples of partnerships between academic and service settings were thoroughly described and best practices suggested, but most lacked formal evaluation of outcomes. An analysis of the main issues discussed in these articles clustered around the following categories: *pre-requisites for successful partnerships, benefits of partnerships, types of partnership,* and *workforce development* with its themes of *academic-practice progression* and *educational redesign.* Key points in each of these categories are described below.

3.1. Pre-Requisites for Successful Partnerships. Many authors not only called for a recommitment to partnering but also identified key pre-requisites to developing and sustaining effective academic-service partnerships [15–34]. They acknowledged that the process of establishing such collaborative relationships can be both difficult and time consuming despite its rewards. Successful partnerships always start with self- and mutual-assessments of strengths and opportunities. From the very beginning, it is essential that each partner bring something valuable to the partnership [15–19]. Key elements of an effective partnership always included mutual trust; shared vision, commitment, and goals; mutual respect; recognition of opportunities and strengths; open and ongoing communication [20–27]. Specific strategies for developing and sustaining partnerships were written, formalized, and measureable goals and ongoing evaluation; strongly articulated institutional leadership support; the ability to take risks and tolerate ambiguity; structured accountability; institutionally shared resources; dedicated time; celebration of successes. While all of the articles reviewed either implied or explicitly stated the difficulties inherent in the process, all reported that if these key elements were in place, success and satisfaction were more likely, leading to sustainability of the partnership.

3.2. Benefits of Partnerships. According to Bleich et al. [3], who are considered thought leaders on the topic of academic-service partnerships in nursing, the benefits that were cited by the American Association of Colleges of Nursing (AACN) in 1990 [7] remain true today. These include strength and power in mutual goal setting, increased visibility and esteem for nursing's contribution to health care delivery, maximization of resources, enhanced opportunity for educators to remain current in practice, cost effective quality care and education of students and staff, increased research productivity, and development of patterns of excellence [7]. Other benefits of academic-service partnerships cited in the literature included improving organizational efficiencies, providing greater opportunities for innovations and new ways of thinking and doing [35, 36], and enhanced recruitment and retention [37].

3.3. Types of Partnerships. Academic-service partnerships have been widely discussed in the literature. These include partnerships with hospitals, community health, and public health agencies, nursing homes, schools, and governmental agencies. From early on in nursing's history, the focus of these partnerships was directed toward providing care to specific populations, educating students and staff, producing research, and addressing workforce issues in nursing. Faculty practice models and centers for research are two examples of partnerships that developed in the mid-20th century. Today, in the early 21st century, the majority of academic-service partnerships are focused on building workforce capacity.

3.3.1. Models of Faculty Practice. Faculty practice models, first seen in the United States in the 1950s [3, 38], emerged as innovative approaches to care for vulnerable populations, support training of advanced practice nurses, build a more educated workforce infrastructure, and advance nursing research [3, 12, 13, 15].

One model of faculty practice was the academic nursing center, housed in the university and staffed by faculty. These centers provided cost-effective care to their neighboring communities [2, 39, 40]. While key challenges were mostly financial, or related to legal and regulatory issues [41], patient outcomes were consistently excellent [42].

While faculty practice had its early roots in academic nursing centers, other popular models allowed for joint appointments for both faculty in a practice setting and the practitioners in the university. In a critical review of 35 articles, Sawyer and colleagues [43] concluded that, by 2000, faculty practice had become an integral component of faculty role expectations at most schools of nursing. Successful faculty practice models are well described in the literature

[44–67]. Authors consistently attributed this success to building a strong infrastructure to support the practice initiative, including administrative support for business, legal, and regulatory oversight [51, 55, 57, 60, 66]. Equally important were trust among partners [57], and a shared and well-articulated mission and vision [54, 55, 58, 60, 61].

The many benefits to faculty practice for all partners, regardless of model employed, included cost effectiveness, good patient outcomes, positive student learning, increased research productivity, and faculty satisfaction [49–64]. Additional benefits to the practice site were opportunities for staff to work with highly knowledgeable and engaged faculty members, and ability to recruit new graduates [63]. The communities served also benefited from the many practice innovations that were generated from the synergies developed between faculty, students, and providers [60]. Today, faculty practice models continue to provide opportunities for nurse practitioner faculty to maintain certification which is critical to accreditation of nurse practitioner academic programs [68].

3.3.2. Centers for Research and Evidence Based Practice. While academic nursing centers and collaborative faculty practice collaborations were typically developed to provide patient care and student learning experiences, research collaborations between faculty and clinicians were often an unanticipated benefit. Development of partnerships for the primary purpose of advancing research and building an evidence-based practice began to emerge soon thereafter [3, 69–75]. In these partnerships, faculty has access to subjects for their research and clinicians have access to research experts and consultation. The outcomes of such partnerships included enhanced evidence-based practice, increased grant funding, and overall improvement in the "generation, dissemination, and application of knowledge for the improvement of nursing practice and patient outcomes" [70, page 114]. These research-focused partnerships have not only enhanced patient outcomes but also provided research training for a new generation of scholars.

3.4. Workforce Development Initiatives. The majority of academic-service partnerships in the past decade have focused on building professional nurse workforce capacity [76]. All of the recent workforce predictions point to a serious nursing shortage. The Robert Wood Johnson Foundation's 2010 report, for example, forecasts a deficit of "more than 260,000 registered nurses by 2025 unless we expand nursing education capacity quickly and dramatically" [76]. Published papers addressing this topic focused on anticipated problems associated with a nursing workforce inadequately prepared to lead and implement change, and the concomitant need for nursing education re-design. Authors proposed strategies to realign academic and service resources, with the goals of improving the quality of prelicensure education, building faculty capacity, and ensuring quality and safety of patient care. Two central themes that emerged in the literature review within this category include *academic-practice progression* and *educational re-design.*

3.4.1. Academic-Practice Progression. In 2008, the Nursing Executive Center [77, 78] published its two-volume report entitled, "Bridging the Preparation-Practice Gap." The first volume [77] of the report detailed the results of a survey of 400 nursing school directors and over 3500 hospital-based leaders on 36 competencies required of new graduates. The result indicated a need for better preparation of students on all 36 competencies. The top ten priorities for improvement included utilization of information technologies, rapport with patients and families, respect for diverse cultural perspectives, patient assessment, customer service, documentation, medication administration, patient advocacy, interdisciplinary team communication, accountability for one's actions, ability to work as a team member, and recognition of when to ask for help [77]. Importantly, the report noted polarized opposing views on practice readiness with "nearly 90 percent of academic leaders believing that their new graduate nurses are fully prepared to provide safe and effective care, compared to only 10 percent of hospital and health system executives" [78, page X]. The Board called for a more collaborative approach to close this significant gap, using strategies such as targeted clinical rotations, expert clinical instruction, and exceptional salient student experiences.

Several approaches have been described to address this gap in preparation to practice readiness. The most wellknown is the senior capstone experience where students work one-on-one with a clinical nurse to care for assigned patients [79, 80]. Reports of other academic-service partnerships have focused on enhancing individual student experiences with vulnerable populations [75, 81–90]; with schools [91, 92], the elderly [93, 94], and in primary care settings [95, 96].

3.4.2. Nursing Education Re-Design. At the same time that the Nursing Executive Center published its reports, data were emerging on how faculty shortages across the country were limiting student capacity [97, 98]. A more formalized educational re-design initiative was one approach to increase faculty capacity and to more effectively match the realities of clinical practice for today and tomorrow. A 2008 white paper [98] jointly commissioned by the RWJ Foundation, the Center to Champion Nursing in America (CCNA), and the U. S. Department of Labor, Employment, and Training Administration described innovative efforts underway to address the nursing faculty shortage. Four approaches to increasing nursing education capacity were described: (1) creating strategic partnerships to align and leverage stakeholder resources; (2) increasing nursing faculty capacity and diversity; (3) re-designing nursing education; (4) flexing policy and regulation [98]. Examples of innovations within these approaches included accelerated entry level BSN programs, centralized clinical placement initiatives, accelerated doctoral programs, adjunct clinical faculty training, the Robert Wood Johnson New Careers in Nursing Program, dedicated education units, nurse residency programs, Nursing Teacher Loan Forgiveness programs, and BSN in 10 legislation [98].

The development of accelerated postbaccalaureate nursing education programs was an early attempt at increasing the nursing workforce. According to the AACN [99], today there are more than 281 accelerated baccalaureate and 63 accelerated master's programs. While impressive in scope, these efforts alone cannot meet the future demands for a well-prepared and adequately numbered workforce. Furthermore, these programs were not designed as academic-service partnerships, and it has become increasingly apparent that nursing must work together to address the issues of workforce capacity. Reinhard and Hassmiller [100], along with Joynt and Kimball [98], described the collaboration between the RWJ Foundation and the American Association of Retired Persons (AARP), to create the Center to Champion Nursing in America (CNAA). The main emphasis of this center is raise awareness of the nursing shortage and to highlight innovative partnerships that are working to resolve this crisis. Between 2009 and 2010, the CNAA at AARP, the RWJ Foundation, the U.S. Department of Labor's Employment and Training Administration, and the U.S. Department of Health and Human Services' Health Resources and Services Administration (HRSA) cosponsored two national summits on nursing education capacity. Exemplars presented at these summits included public and private partnerships designed to prepare the future nursing workforce [76, 101]. Many of these are state-wide initiatives modeled after the Oregon Consortium for Nursing Education (OCNE). This consortium has completely redesigned the nursing curriculum and standardized nursing education in eight of the 15 community college nursing programs and the multicampus Oregon Health and Science University (OHSU) School of Nursing [17, 101, 102]. Other states with robust collaborations between public and private schools of nursing and their practice partners include California, Florida, New Jersey, Hawaii, Massachusetts, Michigan, Mississippi, New York, North Carolina Texas, and Virginia [76, 101]. Reported innovations include: analyses of the preparation-practice gap, seamless admissions and curricula, use of standardized patients, technology and simulation, the development of competencies for the nurse of the future, regional collaborations, retention strategies, centralized clinical placement systems, and faculty development initiatives.

Some of this educational re-design work was developed as a result of AACN's 2003 support to establish the University Health System Consortium [103]. The consortium's purpose was to address the need to ensure a more educated workforce and a more effective transition into the professional role for baccalaureate graduates. Nurse executives and deans from hospitals and schools of nursing in academic health science centers in California, Iowa, Kentucky, Oregon, Tennessee, and Texas formed a joint task force that identified goals around the recruitment, retention, and expansion of baccalaureate students, successful transition through structured residency programs, and a professional and healthy work environment with differential salaries based on academic preparation.

MacIntyre and colleagues [104] recommended five strategies to realign scarce resources of faculty and clinical placements with the goals of improving the quality of prelicensure education, building faculty capacity, and ensuring quality and safety of patient care. They argued (1) that faculty and practice leaders must reconceptualize nursing student and staff relationships as well as the role of faculty by encouraging experienced staff nurses to become more involved in the education of students. (2) Experienced faculty members from the university could then become mentors to novice staff educators who in turn may become excited about pursuing the faculty role. Furthermore, they recommended (3) that schools of nursing develop resources to prepare the novice educators for the teaching role. They encouraged faculty (4) to think about alternative clinical sites and experiences with their practice partners and (5) to build the evidence-based content of the curriculum. As changes such as these require full partnership, they must be based on a sound methodological approach and transparency [105]. If effective, MacIntyre and colleagues [104] concluded that such an approach would increase workforce capacity.

Dedicated education units (DEU) were designed as partnerships and resonate with the suggestions made by MacIntyre and colleagues. One of the first articles to describe the DEU came from Flinders University in Australia and was published in 1999 [106]. A dedicated education unit is a "partnership of nurse executives, staff nurses, and faculty who transform patient units into environments of support for nursing students and staff nurses while continuing the critical work of providing care..." [107, page 31]. The DEU model employs well-prepared RN clinicians as educators for nursing students. Academic faculty serve as role models and mentors to these scholar clinicians. While a number of models have been described [106–112], only a few studies have been published to date evaluating outcomes of this recent innovation [106, 108, 111, 112]. Of these, all concluded that the dedicated education increased educational capacity as well as student and staff satisfaction, and was a good source for clinical placements.

The development of the clinical nurse leader (CNL) role and supporting curriculum is another recent example of academic-service partnership that addresses the preparation-practice gap. The AACN proposed the CNL role in 2003 after consulting with an extensive group of leaders from a variety of settings across the healthcare delivery system. The CNL is a provider and a manager of care at the point of care to individuals and cohorts [113]. The master's level curriculum is based on values and core competencies identified by the Nursing Executive Center [97, 98]. The curriculum also addresses concerns voiced by the Institute of Medicine [114, 115] regarding the fragmentation of healthcare delivery that contributes significantly to the high error rate and decreased quality in patient care. Starting in 2004, 77 academic-practice partners began piloting several CNL demonstration projects. Today, there are more than 108 academic partners and 210 practice partners, a CNL certification examination, and hundreds of CNL graduates across the country. The Department of Veterans Affairs has committed to implementing the CNL role in all VA medical centers by 2016 [116].

Table 1: Suggested outcome measures of effective partnerships.

Outcome measures for effective academic-service partnerships at the individual partner level	Expected outcomes
	The number of quality clinical placements will increase and diversify
	The number of qualified clinical faculty recruited from clinical partnership sites will increase
	The opportunities for shared experiences (research, practice projects, shared teaching, DEUs, etc.) between faculty and clinical staff will increase
	The number of students enrolled will increase along with the quality of students accepted
	Academic progression policies will support excellence
	Student retention will be increased
	Student performance on NCLEX-RN will increase
	Student employment rates post graduation will increase
	Orientation time for new graduates will decrease
	Recruitment and orientation costs to service organizations will decrease
	Retention rates for new graduates will increase
	Patient safety and quality indicators of success will increase
	The percentage of nurses who return for advanced degrees will increase
	Research Productivity will increase
	The percentage of nurses who become leaders within their institutions and beyond will increase
	The percentage of nurses who become politically active will increase
	Satisfaction of students, staff, faculty, and employers will increase
Outcome measures for effective academic-service partnerships at the regional level	The numbers of regional action coalitions will increase and results of their work will be disseminated nationally
Outcome measures for effective academic-service partnerships at the individual level	The AACN-AONE task force on academic-practice partnerships will take a national role in promoting a national level discussion of and implementation plan on best practices and implementation strategies

As is typical with the development of CNL programs, nursing leaders from three New Jersey healthcare organizations partnered with the College of New Jersey to develop their curriculum. They worked together to implement the program with representatives from both practice and the academic settings involved in teaching the students [117]. A focus on clinical relevance was a key element in the curriculum which addressed prior concerns about the preparation-practice gap [97, 98].

Smith and Dabbs [118] published one of the few studies to include patient outcomes in their formative and summative evaluation methodology to assess outcomes of a precursor to the CNL model on a 46-bed medical-surgical unit. A year after implementation, falls with injury were decreased by 67% and pressure ulcer rates decreased to 0%. Patient satisfaction increased and staff turnover decreased. The average length of stay decreased from 4.22 to 3.45 days on the pilot unit and patient satisfaction with discharge planning improved.

4. Discussion and Conclusions

While the literature is replete with descriptions of numerous academic-service partnerships that have developed over the past twenty years, objective evidence for the success of these relationships is limited at best. While much informal evaluation has occurred, very few of the innovations described have been formally studied. Generalizability of research published to date is limited by small, nonrepresentative samples in single locations followed over relatively short time periods.

As academic and service partners move forward to design and implement changes to prepare the next generation of professional nurses for the realities of a changing healthcare delivery landscape, both process and outcome evaluations must be incorporated in the planning. Both research and quality improvement methodologies may be useful, depending on the proposed innovation. The key point is that measurement is essential to determine the short- and long-term effectiveness and the efficiency of these initiatives. We will need to know, for example, the kind and number of staff and faculty resources required to ensure success, and their associated costs. The effect on patient outcomes must also be considered, as well as staff and faculty outcomes, such as readiness for practice and effects on workloads, job satisfaction, recruitment, and retention. Table 1 outlines a more comprehensive list of suggested outcomes to measure partnership success.

Despite the limitations of the extant literature, this integrative review has highlighted a number of successful

or promising academic-service partnerships and associated benefits perceived by the innovators. Thought leaders have also described the prerequisites that should frame future partnerships. The IOM's call [1] is urgent and compelling. Nursing leaders are stepping up to the plate on the local, regional, and national levels to respond to the inherent challenges. Schools of Nursing and their practice partners continue to develop new approaches to solve the problems of the lack of clinical faculty and clinical placements, as well as the nursing shortage. States and regions are responding to the call from the RWJ Foundation to establish Regional Action Coalitions. Leaders from the AACN, the American Organization of Nurse Executives, and the Association of State and Territorial Directors of Public Health Nursing have partnered to form a national task force to identify best practices in academic-service partnerships. The nursing profession eagerly awaits the results from these impressive partnership activities. The time is right to move forward by building together on past successes for both the good of our patients and the continuing development of our professional capacity.

Conflict of Interests

The author declares no actual or potential conflict of interest.

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Research Article

Differences in Perceptions of Patient Safety Culture between Charge and Noncharge Nurses: Implications for Effectiveness Outcomes Research

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The implementation of evidence-based practice guidelines can be influenced by nurses' perceptions of the organizational safety culture. Shift-by-shift management of each nursing unit is designated to a subset of staff nurses (charge nurses), whom are often recruited as champions for change. The findings indicate that compared to charge nurses, noncharge nurses were more positive about overall perceptions of safety ($P = .05$) and teamwork ($P < .05$). Among charge nurses, significant differences were observed based on the number of years' experience in charge: perception of teamwork within units [$F(3, 365) = 3.52$, $P < .01$]; overall perceptions of safety, [$F(3, 365) = 4.20$, $P < .05$]; safety grade for work area [$F(3, 360) = 2.61$, $P < .05$]; number of events reported within the last month [$F(3, 362) = 3.49$, $P < .05$]. These findings provide important insights to organizational contextual factors that may impact effectiveness outcomes research in the future.

1. Introduction

With the increasing emphasis in the efficient delivery of healthcare, healthcare organizations are investing in effectiveness outcomes research to improve patient outcomes. However, the uptake and implementation of evidence-based clinical practice guidelines are influenced by contextual factors such as leadership support and use of change champions [1–3] and personnel perceptions of patient safety [4]. Within acute care settings, nurses' perceptions of patient safety cultures and attitudes towards new practice guidelines are very critical for predicting the use of research evidence and new guidelines [5, 6]. What is known about nurses' perceptions of patient safety culture has been reviewed in comparison with interdisciplinary team members [7–9] and across ranks such as staff nurses versus nurse managers [10]. Yet, staff nurses are not a homogenous group. In most acute care settings for each nursing unit, the management of each shift is designated to a nurse who then leads other staff nurses on that shift. The shift-by-shift leaders may be known as charge nurses, or assistant nurse managers [11, 12] and are often used as champions for change [13, 14]. Since nurses are very pivotal to the implementation of safety guidelines, it is critical to have a deeper understanding of how these two groups of nurses, charge and noncharge nurses, perceive patient safety cultures. The purpose of this paper was to compare the perceptions of nursing units' safety culture between charge nurses and staff nurses. For this study, the charge nurse is defined as a frontline nursing unit leader who makes shift-by-shift decisions about staffing, personnel and unexpected events that impact patient care [15]. In contrast, the noncharge nurse is defined as a staff nurse who is a direct patient care provider and has never had charge nurse experience.

2. Background

The creation of reliable healthcare organizations is fundamental for the process of improving patient care [16, 17]. The use of evidence-based practice guidelines has become widespread as one of several methods healthcare organizations seek to establish safe and reliable practice environments [18, 19]. Notwithstanding, there are many organizational barriers that limit the implementation of practice guidelines [20, 21]. Ricart et al. [22] found that nurses' fear of potential

harm to patients contributed to nonadherence to evidence-based guidelines for the prevention of ventilator-associated pneumonia. Doherty [23] found that the lack of regular nursing staff educational meetings was a barrier to the implementation of adult asthma guidelines in the emergency room. Similarly, in the examination of the use of research in nursing organizations, Estabrooks et al. [5] stated that work and communication patterns characteristic of the nurses and the types of decision making processes predicted variability across organizations. Likewise, the positive perceptions of patient safety culture were associated with greater use of research findings and lower in adverse patient outcomes [2, 3, 24].

However, perceptions of patient safety culture vary across disciplines, healthcare settings, and professional ranks [25, 26]. Notably, leaders are often associated with having more positive perceptions of the safety culture than frontline workers, and managers and physicians generally reported higher levels of positive perceptions of safety as compared to staff nurses [27]. Singer et al. [28] found that among nurses, work experience and work position were significantly associated with perceptions of the patient safety culture. There were more positive reports from nurses who worked on a unit or hospital for more than 10 years, while Kim et al. [10] also found distinctions in perceptions of patient safety culture between staff nurses and managers among healthcare workers, but we would propose that this does not go far enough to examine potential differences between staff nurses and charge nurses.

At the nursing unit-level staff nurses function as either charge or noncharge nurses. Charge nurses generally function as shift-by-shift leaders of nursing units whose duties may vary within and across organizations [29, 30]. Staff nurses tend to be recently hired, mainly provide direct patient care and are supervised by charge nurses [15, 31]. In the implementation of evidence-based practice initiatives, the nurses recruited as change champions can be either charge or noncharge nurses [32, 33].

Similar to findings about other contextual factors influencing effective outcomes research, the impact of opinion leaders is also multifaceted [6, 34]. Curran's [35] study of opinions leaders indicated that the success of an opinion leader in leading change was influenced by acceptance of the role, developmental level of the social networks within organizations clarity of role expectations and perceptions of organizational context. Although positive perceptions of patient safety culture have influenced increased use of practice guidelines as reported by Estabrooks et al. [5] and Cummings et al. [2], there may be challenges to smooth implementation when confronted with differences in perceptions of organizational context experienced by change champions [36, 37]. To disentangle the effects of nurses' perceptions of patient safety culture on the use of evidence-based practice guidelines, it may be necessary to determine whether differences in perceptions do exist between charge and noncharge nurses. With this need, this paper was aimed at exploring the differences in perceptions of safety culture between charge and noncharge nurses.

3. Methods

3.1. Design and Participants. This study used a descriptive, correlational and cross-sectional design to examine the differences in the perceptions of patient safety culture among registered nurses working in 12 adult medical surgical units at a large academic medical center in the Midwest. There were 710 registered nurses working in the 12 units at the time of the study. To be included in this study, the nurses had to have at least six months experience on their current unit and were supervised by a charge nurse or worked as charge nurse. LPNs and nurse managers were excluded from the study.

3.2. Data Collection. Following the approval of the institutional review board (IRB) of the medical center, a modified Dillman method was used to recruit nurses [38]. The design involved engaging the study participants in the following manner: (1) questionnaires in large manila envelopes were placed in staff nurses' unit mailboxes; (2) 1-2 weeks after the study began, a thank you postcard was placed in the mailboxes to express appreciation for completion or as a reminder if the questionnaire had not been returned; (3) 3-4 weeks after, a thank you postcard was placed in mailboxes to express appreciation for completion of survey or as a gentle reminder if the questionnaire had not been returned. Completed surveys were placed in sealed drop boxes located within each nursing unit and sequentially numbered as they were returned. A total of 710 surveys were distributed. Over a 3-month period, 381 nurses returned completed questionnaires and signed consent forms, which yielded a response rate of 54%. Six of the 381 questionnaires were not used in the analyses on account of missing data that exceeded 10% of the total items in the study. The final sample, therefore, consisted of 375 respondents representing 53% of the total possible registered nurses who met the inclusion criteria.

3.3. Measures. The independent variables were charge nurse experience (no charge and some charge), percentage of shifts worked incharge in the past month (<25% and >25%), and number of years as charge nurse on current unit (none, less than 1 year, 1 to 5 years, and more than 5 years). Shift worked was a categorical variable with three options: permanent day, permanent night, and rotating shift. The demographic variables for the study were level of highest degree, length of time in current unit. The educational level options were (1) diploma and associate's degrees; (2) baccalaureate degree; (3) master's degree. Length of time in current unit response categories were (1) less than 1 year; (2) 1 to 5 years; (3) more than 5 years.

There were four dependent variables in the study, namely; overall perceptions of patient safety, number of events reported, teamwork within units, and safety grade. These dependent variables are four of the eleven subscales of the AHRQ Hospital Survey on Patient Safety Culture survey [39]. Researchers have found the AHRQ Hospital Survey on Patient Survey Culture to be reliable ranging from .72 to .84 with the exception of the staffing dimension (.63) [7]. In this

study, the Cronbach alpha for overall perceptions of safety was .70, and teamwork within units was .80 [7]. Safety grade and number of events reported were single items.

3.4. Data Analysis. The statistical package for the social sciences (SPSS) software version 18.0.3 was used for analyses of the data. At the completion of data entry, there were fewer than 5% of missing items. Following the guidelines of McKnight et al. [40], this is below the 10% threshold. Therefore, the items were not deleted and were included in data analysis. Mean substitution done to impute the values for the missing items. t-tests were conducted to test the hypothesis that there were differences in patient safety culture between nurses with no charge and some charge experience. Pearson's chi-square test was utilized to test the relationship between percentages of shifts in charge during the past month. ANOVA technique was utilized to examine differences in the perceptions of patient safety among nurses with varying percentages of shifts in charge and number of years as charge nurse during the past month.

4. Results

The descriptive characteristics of the study sample can be found in Tables 1 and 2. The sample of registered nurses consisted of 215 nurses with some charge experience and 159 without charge experience. Six out of ten of the nurses with no charge experience had a bachelor's degree as compared to five out of ten of those with some charge experience. The nurses who were never in charge worked mainly during the rotating shifts (46%) with the least (17%) working the permanent day shift and 37% working the permanent night shift. A somewhat opposite pattern was noted in the nurses with some charge experience: 47% worked during the day; 31% at night; 22% percent worked as shift rotators. Of the nurses who were in charge, 47% worked on the current unit for more than six years compared to 12% of the staff nurses. Only 31% of the nurses functioned in the charge role for greater than twenty-five percent of shifts worked, while 25% were in charge for less than twenty-five percent of the shift worked, and the remaining 44% were never in charge. Interestedly, only 6% of the charge nurses self-identified as being permanent in the role in that they were in charge for 75% or greater of shifts worked. The educational preparation for those who were charge nurses was captured by number of shifts for shadow-charge orientation. Eight percent of the charge nurses stated they had no shadow-charge orientation. The majority (63%) of charge nurses had one to two shifts, while 29% had 3 or more shifts of shadow charge experience.

A two-tailed t-test for independent groups was used to test the hypothesis that the nurses with no charge and some charge experience will have differences in perception of safety. Significant differences were observed with two dimensions of the patient safety culture. The t-test revealed that for nurses with no charge experience the mean (3.46) for overall perception of safety was significantly higher than for the nurses with some charge experience (3.27), [$t(374) = 2.86$, $P = .005$]. Consistent with that finding, for the dimension number of events reported within a 12-month period, the nurses with some charge had a higher mean (2.31) than nurses with no charge experience (2.06), [$t(368) = -3.35$, $P = .001$]. These findings are summarized in Table 3.

The nurses with no charge experience reported fewer events. No events were reported by 21% of the nurses with some charge experience versus 14% of those with no charge experience. Of those who reported 1 to 2 events, 52% were reported by nurses with no charge experience as compared to 42% with some charge experience. As the number of events increased to 3 to 21 events, the nurses with some charge

Table 1: Sample characteristics.

Variable	Frequency	
	N	Percentage
Shift normally worked ($n = 333$)		
Day	114	**34.2**
Night	113	**33.9**
Shift rotators	106	**31.8**
Number of years as registered nurse on current unit ($n = 373$)		
Less than 1 year	33	**8.8**
1 to 5 years	220	**59.0**
6 or more years	120	**32.2**
Highest degree obtained ($n = 375$)		
Diploma and associate	144	**38.4**
Baccalaureate	205	**54.7**
Masters	26	**6.9**

Table 2: Charge nurse characteristics.

Variable	*N*	Percentage
Charge nurse experience ($n = 374$)		
(1) some charge	215	57.5
(a) permanent charge	23	**6.1**
(b) relief charge	192	**51.3**
(2) no charge (staff nurse)	159	**42.5**
Percentage shifts worked incharge in the past month ($n = 207$)		
<25% of shifts worked	92	44.4
>25% of shifts worked	115	**55.5**
Number of years as a charge nurse on current unit ($n = 228$)		
Less than 1 year	30	13.2
1 to 5 years	114	50.0
More than 5 years	84	**36.8**
Shadow-charge orientation ($n = 228$)		
None	17	7.5
1-2 shifts	144	**63.2**
3 or more shifts	67	**29.4**

Table 3: t-tests for charge nurse experience and AHRQ perception of patient safety culture.

Outcome*	No charge (n = 159) Mean (SD)	Some charge (n = 215) Mean (SD)	t-value	P**
Overall perceptions of safety	3.46 (0.61)	3.27 (0.63)	2.86	.01
Number of events reported within the last 12 months	2.06 (0.70)	2.31 (0.70)	−3.35	.01

*Outcome was rated from 1 (strongly disagree) to 5 (strongly agree).
**Two-tailed P value.
Table only includes significant findings, full results can be obtained from corresponding author.

Table 4: Chi-square for charge nurse experience and AHRQ perception of patient safety culture.

Variable	No event	1-2 events	3–21 events	Total
None	32 (19.9)	84 (52.2)	45 (28.0)	161
Less than 25%	11 (12.2)	42 (46.7)	37 (41.1)	90
More than 25%	18 (15.7)	42 (36.5)	55 (47.8)	115
Total	61	168	137	366

$X^2(4) = 13.240$; $P = .010$.

experience (45%) reported more events versus 27% of the nurses with no charge experience.

The Pearson's chi-square test was utilized to test the relationship between percentage of shifts in charge during the past month and number of events reported in the past month. As shown in Table 4, fifty-two percent of the nurses with no charge experience reported 1 to 2 events; 20% reported no events; 28% reported 3 to 21 events. The nurses with no charge experience were almost equally divided between no events (20%) and 3 to 21 events (28%). The nurses with less than 25% of the shifts worked had the highest percent (47%) reporting 1 to 2 events, which is similar to the nurses with no charge experience. Moreover, 41% reported 3 to 21 events and 12% reported no events. Of the nurses who were in charge for more than twenty-five percent of shifts worked, 37% reported 1 to 2 events; 48% reported 3 to 21 events; 16% reported no events.

The nurses with no experience (20%) had a higher percentage of reporting no events as compared to the nurses with less than twenty-five percent of shifts in charge (12%) and more than twenty-five percent of shifts in charge (16%). The nurses who were in charge for greater than twenty-five percent of shifts worked reported 3–21 events three times more than they reported no events. In the category of 1 to 2 events, there was a higher percentage of nurses with no charge experience (52%) reporting as compared to the nurses with some experience. The nurses with some charge experience tended to report more events.

Utilizing ANOVA technique, differences in the perceptions of patient safety among nurses with varying percentages of shifts in charge during the past month were significant differences in overall perception of safety, [$F(2,369) = 3.27$, $P < .05$]. Bonferroni's post hoc test showed that there were differences between nurses with no charge nurse shifts and those with greater than 25% of shifts in charge in the last month.

There were also variations among the number of years as charge nurse for the perceptions of teamwork within units [$F(3,365) = 3.52$, $P < .01$], overall perceptions of safety, [$F(3,365) = 4.20$, $P < .05$], safety grade for work area [$F(3,360) = 2.61$, $P < .05$], and number of events were reported within the last month [$F(3,362) = 3.49$, $P < .05$]. Further analysis using Bonferroni's post hoc tests indicated the differences in perception of patient safety among the nurses with less than one year, one to five years and more than five years as charge nurse for teamwork within hospital units, the nurses with less than one year of experience were more positive than nurses with more than 5 years ($P < .05$). For overall perceptions of safety, the nurses who were never in charge had more positive perceptions of safety than those who were in charge for one to five years for more than 5 years ($P < .01$). The differences in safety grade for work area were between the nurses with no charge, who were more positive than the nurses with more than five years of charge experience ($P < .05$), and for the number of events reported within the last twelve months the nurses who were never in charge were more positive than those with one to five years of charge experience ($P < .05$).

5. Discussion

The purpose of the study was to evaluate whether differences in perceptions of safety exist between charge and staff nurses. Differences in perception of patient safety culture between and among charge nurses were established in this study. Specifically, we found that there were differences observed in perceptions of teamwork within the unit; overall perceptions of safety; safety grade for area; number of events reported within the last twelve months according to the number of years as a charge nurse. Nurses with no charge experience had more positive overall perceptions of patient safety, while the nurses with some charge experience had less positive overall perceptions of safety. Charge nurses with one to five or more than five years of experience were less positive about teamwork, overall perceptions of safety, safety grade for work area, and number of events reported. The percentage of shifts worked in charge in the past month provides more information about the differences observed between the

charge and noncharge nurses. The results support differences in overall perception of safety between the nurses with greater than 25% of shifts in charge and with no shifts in charge. Chi-square tests for the patient safety grade for work area and charge nurse experience revealed no significant findings.

These findings run counter to the results from previous studies which indicate that there are less positive perceptions of patient safety by frontline nurses in general [7, 8]. Kim et al.'s [10] study about nurses' perceptions of patient safety included 10% ($n = 86$) charge nurses, but they did not report findings that compared charge nurse perceptions of patient safety with those of other groups of nurses. Unlike Kim et al. [10], this current paper focuses on charge nurses as a discrete group. In a previous study, registered nurses in general with more experience and length of time on the unit were more positive about patient safety culture [10]. Other studies about perceptions of patient safety culture included nurses as a monolithic subset among healthcare providers such as physicians, clinical or nonclinical managers, and technicians [26]. In this regard, this current study marks an important departure from other empirical findings about role of leaders in perceptions of patient safety in health care organizations, especially as it pertains to nurses. This, in turn, may have important implications for how these leaders promote implementation of evidence-based practice as well.

In other findings, new graduates tended to make more medication errors [41] and are perceived to contribute more to errors than older, more experienced nurses [42]. Previous studies had also shown that new graduates were less positive about their work environment because they are more stressed adjusting to the work environment [43], emotionally exhausted [44], or overwhelmed [45]. However, the finding in this study that indicated the new graduates were more positive about perceptions of safety may be due in part, to observations that they may not have received adequate education about patient safety [46], may be more focused into developing critical thinking skills or their personal safety practices as against the demands of collective unit responsibility [47].

The differences in safety perceptions between nurses with no and some charge experiences may be explained by the fact that the charge nurses have a broader overview of potential and real safety errors and may be more familiar with the error reporting system or are more aware of the errors occurring on the unit than staff nurses, which influences their perceptions of patient safety adversely. Further, even differences noted among nurses who have charge experience. In a previous study, registered nurses with more experience and length of time on the unit were more positive about patient safety culture [10]. In this study, the more experienced charge nurses were less positive about patient safety culture. This may be indicative of a lack of full expertise by those who are in charge for less than 25% of shifts worked. Therefore, the nurses who move in and out of the charge nurse role and spend more time as a staff nurse than a charge nurse may share the same perspectives of the patient safety culture as staff nurses who were never in charge.

The charge nurse role is separate and distinct from the staff nurse role. Patient safety culture is perceived differently by charge nurses; isolating these differences may help to address the variations in nurses' involvement in evidence-based practice guidelines. If the charge nurses are expected to serve as champion of change for effectiveness research initiatives, tailored educational approaches may be necessary based on their length of time as a charge nurse.

6. Limitations

First, this was a cross-sectional study, and the causal direction of the variables used in the study cannot be determined. Second, the study was conducted in a single, large academic medical center. The lack of designated charge nurse positions in this study setting made it difficult to truly test for differences in charge experience as nurses moved in and out of that role. Third, the use of a convenience sample is often associated with selection bias that may limit the generalizability of the results. For example, a greater percent of nurses with a bachelor's degree participated in the study. Future studies that use a probability sample design may increase the likelihood that the sample is representative of the population of charge nurses from which the sample was drawn.

7. Implications

Researchers and nurse managers who are interested in improving the safety culture and effectiveness research initiatives may benefit from assessments of the effects of contextual factors on implementation [48]. Understanding that differences in perceptions exist between nurses with varying levels of charge nurse experience may shed light on the mixed results found in the study by Rich et al. [49] about the use of opinion leaders and change champions for the uptake of practice guidelines. Proper training of healthcare team members is essential to develop effective partnerships for research implementation [50]. The success of utilizing evidence-based practice relies on the use of care providers members who serve to clarify program objectives and motivate colleagues [22, 50]. Nurse champions are most effective when the implementation strategy is tailored to meet the organizational contextual need [1]. The charge nurses were less positive than noncharge nurses about perceptions of patient safety culture. Charge nurses may be able to provide nuanced insights about the state of the patient safety culture, which can be explored further by including them in discussions about new initiatives. The effective use of charge nurses as change champions in implementation studies may necessitate their participation in the planning stages for the implementation of new practice guidelines and training about implementation strategies.

8. Conclusion

This study highlights the importance of charge and noncharge nurses' perceptions of patient safety culture. Recognition of the importance of the charge nurse role in the

assessment of patient safety culture may serve to improve the effective use of nurses as change champions. Future studies should assess the association of the implementation of evidence-based practice guidelines and perception of patient safety culture among nurses.

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Research Article

Multidisciplinary Treatments, Patient Characteristics, Context of Care, and Adverse Incidents in Older, Hospitalized Adults

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The purpose of this study was to examine factors that contribute to adverse incidents by creating a model that included patient characteristics, clinical conditions, nursing unit context of care variables, medical treatments, pharmaceutical treatments, and nursing treatments. Data were abstracted from electronic, administrative, and clinical data repositories. The sample included older adults hospitalized during a four-year period at one, academic medical facility in the Midwestern United States who were at risk for falling. Relational databases were built and a multistep, statistical model building analytic process was used. Total registered nurse (RN) hours per patient day (HPPD) and HPPDs dropping below the nursing unit average were significant explanatory variables for experiencing an adverse incident. The number of medical and pharmaceutical treatments that a patient received during hospitalization as well as many specific nursing treatments (e.g., restraint use, neurological monitoring) were also contributors to experiencing an adverse incident.

1. Background

The Institute of Medicine (IOM) report *To Err is Human* [1] revealed the number and significance of adverse events and errors that occur during hospitalization. The report was a call to action to transform healthcare systems to ensure patient safety and higher quality care. In one step toward healthcare transformation, the Centers for Medicare and Medicaid (CMS) no longer reimburses institutions for the care, or treatment, associated with certain hospital-acquired conditions [2].

Understanding what factors contribute to adverse incidents during hospitalization is essential to developing effective counter measures. In order to improve factors that are modifiable within a hospital structure or with healthcare delivery, it is important to first have an understanding of what is broken. There are a number of potential contributing factors that need to be considered such as the patient's condition, the care the patient receives, and the environment in which they receive care [3, 4].

Battles and Lilford [3] provide a conceptual model for patient safety that includes antecedent conditions, which would include the patient's comorbid conditions, the primary reason the patient was admitted to the hospital, and characteristics the patient possessed before entering the hospital. Their model also includes the structure, or environment, in which the patient receives care such as the hospital, or nursing unit. Also acting within the structure are the processes of care (the interventions or treatments) delivered by the multidisciplinary team caring for the patient in the hospital. None of these components exist in isolation, which is why it is important to examine all of these factors and how they interact [3].

2. Purpose

The purpose of this study was to examine factors that contribute to adverse incidents that occur during hospitalization by creating a model that included patient characteristics, clinical conditions, nursing unit context of care variables,

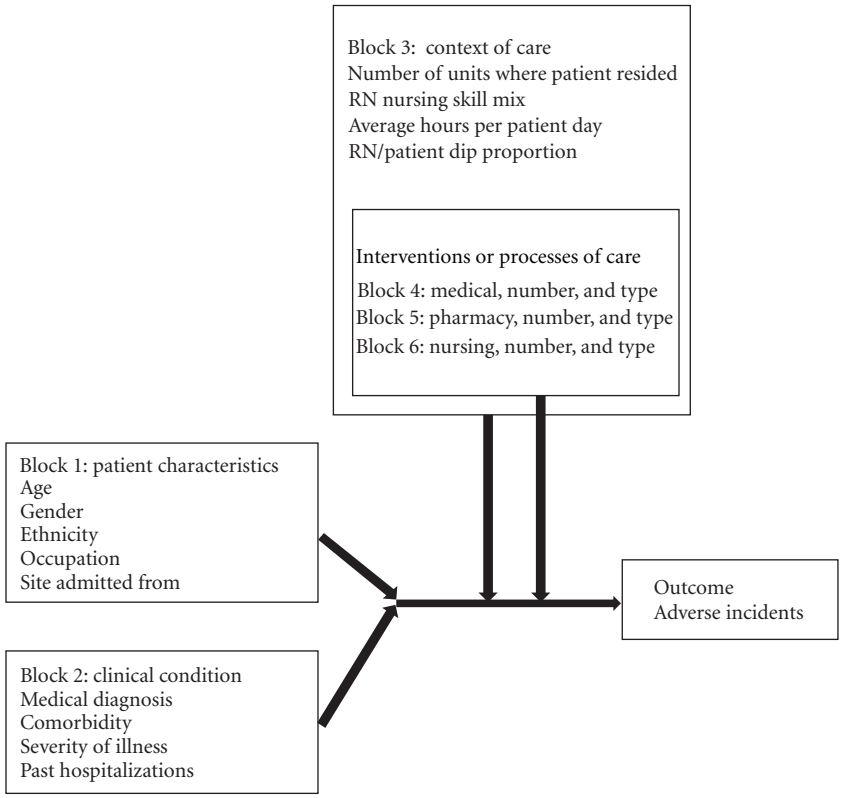

Figure 1: Model for predicting adverse incidents in the hospital.

medical treatments, pharmaceutical treatments, and nursing treatments. The research question addressed in this study is: what patient characteristics, clinical conditions, context of nursing care variables (e.g., nursing hours per patient day, RN skill mix, number of units resided on during hospitalization), and treatments (medical, pharmaceutical, and nursing treatments) explain the occurrence of adverse incidents for hospitalized, older adults at risk for falling? A model that has been used successfully to guide multidisciplinary effectiveness research in the hospital setting can be seen in Figure 1 [5, 6].

3. Methods

Data for this exploratory study came from a large, health service effectiveness grant [7] and was approved by the institution's Human Subjects review board. Data from a four-year period (July 1, 1998 to June 31, 2002) were extracted for the primary study from one large Midwestern academic medical center. Data sources came from nine electronic data repositories, including the nursing information system that used the Nursing Interventions Classification (NIC) [8] to electronically document nursing care delivered. Detail of the nine electronic repositories and methods to assure validity and reliability are discussed elsewhere [5]. Extracted data were stored in a structured query language (SQL) server and relational databases were built using a unique subject number.

3.1. Sample. The inclusion criteria were hospitalizations to one Midwestern tertiary care hospital over a four-year period, patients 60 years of age or older upon admission, and at risk of falling. Patients were determined to be at risk of falling based on a fall risk assessment [6] that was completed upon admission or when the patient received the nursing intervention of Fall Prevention as recorded in the electronic documentation system. Patients at risk for falling were selected with the rationale that they would be at risk for experiencing one adverse incident (i.e., falling), and therefore interventions would be initiated to prevent the adverse incident. In addition, the hospitalizations were selected as the unit of analysis rather than individual patients and a variable was included to control for patients who had more than one hospitalization.

3.2. Study Variables. Conceptual and operational definitions for the independent variables included in the explanatory model are displayed in Table 1 and organized by the conceptual model seen in Figure 1 (patient characteristics, clinical conditions, context of care, and treatments). When appropriate, the source used to guide coding of variables is provided; for example, pharmaceutical treatments, or medications, were coded using the American Hospital Formulary Service (AHFS) codes [9].

The dependent variable for this analysis was the first occurrence of an adverse incident during an episode of hospitalization. Adverse incidents were defined as any undesired

Table 1: Independent variable definitions.

Variable name	Variable definition and coding source	Variable type and operational definition
Patient characteristics		
Gender	The behavioral, cultural, and psychological traits typically associated with one's sex.	Categorical: M = male, F = female, D = deferred (not determined yet).
Age	Age when patient was admitted to hospital.	Continuous; measured in years.
Occupation	Activity pursued as a livelihood.	Categorical: 1 = retired, 2 = working/employed, 3 = homemaker, 4 = not retired/not employed.
Ethnicity	Race: a group of people united by certain characteristics.	Categorical: 1 = Caucasian, 2 = all others (includes the categories of African American, Hispanic, Native American/Alaskan Native; Asian/Pacific Islander, and other).
Site admitted from	The site from which the patient was admitted to the hospital.	Categorical: 1 = hospital, 2 = care facility, 3 = home/other routine admission.
Clinical conditions		
Primary medical diagnosis	The primary medical diagnoses came from the International Classification of Diseases, 9th Revision (Clinical Modification) (ICD-9-CM) codes [10] found in MRA diagnostic codes and have been classified into Clinical Classification Software (CCS) categories [11].	Dichotomous: 0 = no, the diagnosis (i.e., as represented by a particular CCS category) is not the primary diagnosis, 1= yes, the diagnosis (i.e., as represented by a particular CCS category) is the primary diagnosis.
Severity of illness	A rating assigned to each hospital visit retrospectively to measure organ system loss of function or physiological decompensation. Coded using the All Patient Refined Diagnosis Related Groups (APR-DRGs) [12].	Integral: 1 = mild, 2 = moderate, 3 = major, 4 = severe.
Comorbid conditions	Clinical conditions that exist before admission are not related to the principal reason for hospitalization and are likely to be significant factors influencing mortality and resource use [13].	Each of 30 comorbid medical conditions is treated as a dichotomous variable: 0 = no, the condition was not present at time of admission, 1 = yes, the condition was present at the time of admission.
Past hospitalizations during the study period	The number of previous hospitalizations that the patient experienced during the study period.	Integral: 0 = no previous hospitalizations, 1 = 1 previous hospitalization, 2 = 2 previous hospitalizations, 3 = 3 previous hospitalizations, and 4 = 4 or greater previous hospitalizations.
Context of care variables		
Average CGPR-RN	For an entire visit, the average number of all hourly CGPR RN values [14] for the visit. The hourly CGPR RN values serve as the building blocks for this variable and are calculated by dividing the total RN hours for a one-hour period by the total patient hours for that same 1-hour time period.	For each 1 hour of the visit, calculate: total no. of RN hours for a 1-hour time period total no. of patient hours for that same hour and then calculate: sum of hourly CGPR RN values for the entire hospitalization total hours of hospitalization.
Nursing skill mix	Proportion of RNs to all nursing direct caregivers for a specified time period.	The average of the hourly RN values was obtained by dividing the total number of RNs for all hours by the total number of hours for the hospital visit. The average of the total caregiver hours was obtained by dividing the total number of caregivers for all hours by the total number of hours for the hospital visit.

Table 1: Continued.

Variable name	Variable definition and coding Source	Variable type and operational definition
CGPR RN dip variable	The extent to which the minimum amount of RN care falls below the average of all the hourly CGPR values for the entire visit. This represents the variability in the amount of RN care that is available, specifically the extent to which the amount of RN care available drops below the average amount of RN care available for the hospital visit.	Average CGPR-RN minus the average of the three lowest hourly CGPR RN values for the visit. The larger this value is, the more the minimum CGPR RN fell below the average for the visit.
Number of units resided on	The sum of the number of units on which treatment was provided to an individual patient during the course of the hospital visit.	Integral: 1 = 1 unit, 2 = 2 units, 3 = 3 units, 4 = 4 units, 5 = ≥ 5 units
Treatments		
Number of medical treatments	Medical procedures performed during a hospital visit to diagnose and treat a given patient based upon a physician's judgment and knowledge to promote or maintain health, cure diseases, or palliate incurable diseases. Coded using ICD-9-CM codes [10] from the medical record abstraction (MRA) and regrouped into multilevel CCS categories [11].	Continuous: a count on the number of medical treatments that were performed during the course of a hospital visit, this is not the number of unique medical treatments.
Types of medical treatments	Any procedure that, based upon a physician's judgment and knowledge, is necessary to promote or maintain health, cure diseases, or palliate disease processes that are incurable. Coded using ICD-9-CM codes [10] from the MRA and regrouped into multilevel CCS categories [11].	Dichotomous: 0 = no the treatment (i.e., as represented by a particular CCS category) was not received during hospitalization, 1 = yes, the treatment (i.e., as represented by a particular CCS category) was received at least once during hospitalization.
Number of unique medications	The count per visit of unique generic drug names for drugs administered at least once during a visit. Medication types were coded using the American Hospital Formulary Service's (AHFS) three-level system [9].	Continuous: a count of the number of unique medications delivered during a hospital visit.
Pharmacy treatments	Medications used in the care of patients during a hospital visit. Medication types were coded using the AHFS three-level system [9].	Dichotomous: 0 = no medication from the AHFS class was administered during the hospital visit, 1 = yes, at least one medication from the AHFS class was administered at least once during the hospital visit.
Number of unique nursing treatments	The number of unique nursing treatments delivered during the hospital visit. Captured using NIC [8, 15].	Continuous: a count of the unique nursing treatments delivered during the hospital visit.
Nursing treatments	Any treatment nursing personnel performed to enhance patient outcomes. Captured using NIC [8, 15].	Categorical: (multilevel) [16]. (a) NIC used in >95% of visits; divided into quartiles 1 = 1–25% (lowest use rates, includes 0 use), 2 = 26–50% quartile, 3 = 51–75% quartile, 4 = 76–100% quartile (highest use rates). (b) NIC used in ≤95% and >5% of visits; divided into thirds: 0 = NIC not used, 1 = 1–33% lowest third, 2 = 34–67% middle third, 3 = 68–100% top third. (c) NIC used in <5% of the visits 0 = did not receive the NIC, 1 = did receive the NIC.

circumstance that lead to, or could have led to, personal harm. Adverse incidents were collected by the internal incident reporting system at the institution. Adverse incidents included falls, medication errors, procedure-related events (e.g., wrong patient, wrong procedure or test), equipment-related events (e.g., equipment malfunction, unplanned removal, improper set-up), and new conditions (e.g., skin breakdown).

4. Analytic Procedures

Due to the large number of study variables, a four-step model building process using logistic regression was used to answer the research question.

4.1. Step One. Each independent variable included in the analysis was tested independently using a bivariate analysis and a Score Statistic to determine the association with occurrence of an adverse incident. In this bivariate analysis, no other variables were statistically controlled for. Variables with P values ≤ 0.15 were retained for step two. A P value ≤ 0.15 was used as the criterion to guard against eliminating variables too soon in this exploratory analysis.

4.2. Step Two. The variables retained in step one (P values ≤ 0.15) were then analyzed within their respective conceptual variable blocks (i.e., patient characteristics, clinical conditions, context of care, medical treatments, pharmaceutical treatments, and nursing treatments) using logistic regression. A backward elimination process was used, indicating that the variable with the largest P value was eliminated and the analysis was rerun on the remaining variables within the block. This procedure was repeated until all variables within the block had a P value ≤ 0.15. A P value of ≤ 0.15 during step two was chosen to guard against eliminating variables too soon because they might yet prove to have a statistically significant effect when combined with variables from other conceptual blocks.

4.3. Step Three. A model integrating all of the conceptual variable blocks was built in a progressive fashion using the variables that were retained in step two. The significant variables were added to the model by their respective blocks. Starting with the significant variables in block one (patient characteristics) and block 2 (clinical conditions), a model was built using the backward elimination process described in step two until the only variables remaining in the model were those with a P value ≤ 0.15. The significant variables from block three (context of care) were then added to what remained of blocks one (patient characteristics) and two (clinical conditions) in the model. Once again, a backward elimination process was performed until the only variables remaining in the model were those with values ≤ 0.15. This process of adding blocks and using the backward elimination continued until the last block (nursing treatments) was added. At this point, when the significant variables from the final block were added and backward elimination was performed, the criterion for significance was decreased to a P value ≤ 0.05. This resulted in a final model containing only those variables with a P value ≤ 0.05. In step three, variables with a P value ≤ 0.05 in the logistic regression indicated that variables were significantly related to the dependent variable (occurrence of an adverse incident) after controlling for the other variables in the model.

4.4. Step Four. Covariates used for risk adjustment included age, severity of illness, and number of hospitalizations during the study period (see Table 2). Step four added these covariates used for risk adjustment (severity of illness, age, and more than one hospitalization during the study period) to the model to those that were significant in step three. Categorical variables with more than two categories were analyzed by comparing each level to a reference category. For example, severity of illness (four levels from minor to severe) was analyzed by comparing each of the three upper level categories to the lowest level of severity of illness (i.e., minor).

5. Results

There were 10,157 hospitalizations included in this analysis, comprised of 7,851 unique patients. The mean age was 73.7 years; most were retired (74.4%), Caucasian (93.5%), female (52.6%), and admitted from home (64.4%). This patient group, defined primarily by receiving the nursing treatment Fall Prevention, was medically diverse. The most common primary medical diagnoses were diseases of the circulatory system (28.5%), neoplasms (13.8%), and injury, including fractures, or poisoning (11.5%).

There were 1,568 hospitalizations that experienced at least one adverse incident in this sample. The most commonly experienced adverse incident for this patient group included medication errors (37%), falls (27%), and equipment-related events (14%).

Results of the model building process are illustrated in Table 2 by variable blocks. The bivariate correlations completed in step one are not included in Table 2 due to space constraints but are available from the authors upon request. The second column in Table 2 illustrates variables retained from step one that were analyzed within blocks with P values ≤ 0.15 (step two of model building) and thus retained for step three. The third column includes P values from the third part of the modeling building process, prior to adding covariates used for risk adjustment to the final model (step four). The final model is illustrated in Table 3.

Five patient characteristics entered step one of the model building process but none were significant beyond step two. *Age*, although not significant in any of the three model building steps, was entered in the final model for risk adjustment [17]. *Age* was not significant in the final model (see Table 3).

Nine primary medical diagnoses were retained from step two, four were retained from step three, and three were retained ($P \leq 0.05$) in the final model (see Tables 2 and 3). As the results in Table 3 indicate, *other nervous system disorders, other primary cancer* and *senility and organic mental disorders* were all significant ($P \leq 0.05$) in the final model. *Other nervous system disorders* was the only

Table 2: Results from the model building process for determining explanatory variables of experiencing an adverse incident.

Variable	Significant P values ($P \leq 0.15$) for within block correlations	Significant P values ($P \leq 0.05$) for the final model
Patient characteristics		
Ethnicity	0.0029	
Site admitted from	<0.0001	
Clinical conditions		
Primary medical diagnoses (% of sample)		
Cancer, other primary (1.7)	<0.0001	0.0010
Maintenance chemotherapy, radiotherapy (1.1)	0.1408	
Fluid and electrolyte disorder (1.6)	0.0172	
Senility & organic mental disorders (3.0)	<0.0001	0.0140
Affective (2.1)	0.0007	
Other nervous system disorders (1.1)	0.0686	0.0176
Respiratory (3.1)	0.0687	
Chronic obstructive pulmonary (1.8)	0.0332	
Symptoms, signs, and ill-defined conditions (1.8)	0.1034	
Severity of illness	<0.0001	
Congestive heart failure (11.8)	0.0155	
Other neurological disorders (3.6)	0.1218	
Diabetes (17.7)	0.0347	
Peptic ulcer disease without bleeding (4.4)	0.0985	
Rheumatoid arthritis/collagen vas (4.0)	0.0918	
Psychoses (5.7)	0.0211	
Depression (6.6)	0.0237	
Severity of illness		
Severity of illness	<0.0001	
Elixhauser comorbid conditions (% of sample)		
Congestive heart failure (11.8)	0.0155	
Other neurological disorders (3.6)	0.1218	
Diabetes (17.7)	0.0347	
Peptic ulcer disease without bleeding (4.4)	0.0985	
Rheumatoid arthritis/collagen vas (4.0)	0.0918	
Psychoses (5.7)	0.0211	
Depression (6.6)	0.0237	
Past hospitalizations		
Past hospitalizations	0.0199	
Context of care variables		
Number of units resided on	<0.0001	
CGPR dip proportion	<0.0001	0.0092
Skill mix	0.0003	
Average caregiver patient ratio	<0.0001	<0.0001
Treatments		
Medical treatments		
Total number of procedures	<0.0001	0.0059
Types of medical treatments (% of sample)		
Incision and excision of CNS (2.0)	0.0059	
Incision of pleura, thoracentesis, chest drainage (3.8)	0.0637	
Coronary artery bypass graft (CABG) (3.1)	<0.0001	

Table 2: Continued.

Variable	Significant P values ($P \leq 0.15$) for within block correlations	Significant P values ($P \leq 0.05$) for the final model
Diagnostic cardiac catheterization, coronary arteriography (7.9)	0.0007	
Other therapeutic procedures, hemic and lymphatic system (2.8)	0.1205	
Upper gastrointestinal endoscopy, biopsy (6.6)	0.0062	
Gastrostomy, temporary and permanent (1.5)	0.1035	
Oophorectomy, unilateral & bilateral (1.3)	0.0062	
Partial excision bone (1.5)	0.0769	
Treatment of fracture or dislocation (2.3)	0.0513	
Arthroplasty (3.0)	0.0014	
Amputation of lower extremity (1.1)	0.1257	
Spinal fusion (1.0)	0.0089	
Debridement of wound, infection or burn (1.5)	0.0395	
Arterio or venogram (not heart or head) (2.2)	0.0091	
Diagnostic ultrasound (33.5)	0.0048	
Radioisotope scan (6.6)	0.0667	
Physical therapy (4.7)	<0.0001	0.0015
Psychological and psychiatric evaluation and therapy (1.8)	<0.0001	
Enteral and parenteral nutrition (9.5)	0.0063	
Pharmaceutical treatments		
Number of unique medications	<0.0001	<0.0001
Types of pharmaceutical treatments (% of sample)		
Sympathomimetic (adrenergic) agents (17.3)	0.0241	
Anticholinergic agents (13.5)	0.0054	
Skeletal muscle relaxants (5.4)	0.0140	
Cardiac drugs (64.8)	0.0445	
Hypotensive agents (37.7)	0.0882	
Psychotherapeutic agents (35.0)	<0.0001	
Succinimides (27.8)	<0.0001	0.0015
Miscellaneous central nervous system agents (3.9)	0.0923	
Opiate antagonists (1.4)	0.0669	
Anorexigenic agents and respiratory & cerebral stimulants (1.4)	0.0146	
Caloric agents (51.8)	0.0244	0.0128
Irrigating solutions (7.3)	0.0414	
Ammonia detoxicants (2.7)	0.0785	0.0274
EENT anti-infectives (42.2)	0.0002	0.0148
EENT carbonic anhydrase inhibitors (2.2)	0.0404	
Miscellaneous GI drugs (59.8)	0.1098	
Parathyroid (1.4)	0.0228	
Anti-infectives (21.5)	0.0346	
Anti-inflammatory agents (6.8)	0.0438	
Multivitamin preparations (18.7)	0.0425	
Vitamin B complex (7.4)	0.1130	
Unclassified therapeutic agents (34.0)	0.0619	
Tetracyclines (1.3)	0.1135	
Opiate agonists (64.0)	0.0034	
Barbiturates (2.8)	0.0014	
Benzodiazepines (56.2)	0.0024	

Table 2: Continued.

Variable	Significant P values ($P \leq 0.15$) for within block correlations	Significant P values ($P \leq 0.05$) for the final model
Misc. anxiolytics, sedatives, & hypnotics (17.8)	0.0022	
Nursing treatments		
Nursing treatment types (% of sample)		
Fluid management (99.5)	0.0098	
Bathing (93.5)	0.0600	
Pressure ulcer care (91.5)	<0.0001	0.0005
Bowel management (88.2)	0.1049	
Teaching (81.5)	0.0003	
Discharge planning (76.0)	0.0042	
Routine care: adult (56.2)	0.0626	
Health screening (48.8)	<0.0001	<0.0001
Sleep enhancement (47.7)	0.0572	
Oxygen therapy (42.4)	0.0008	
Post-op care (27.8)	<0.0001	
Wound care (21.4)	0.0137	
Neurologic monitoring (20.2)	0.0002	0.0003
Analgesic administration (17.2)	0.0723	
Fluid/electrolyte monitoring (15.1)	0.0365	
Medication management (12.2)	0.0678	
Nutrition management (11.3)	0.0022	
Embolus precautions (9.4)	0.0687	
Infection protection (8.9)	0.0182	
Enteral tube feeding (9.4)	0.0042	
Blood products administration (8.6)	0.0004	0.0192
Restraint (8.5)	<0.0001	<0.0001
Postprocedure care (5.6)	0.0219	
Specimen management (5.3)	0.0079	0.0098
Active listening (4.8)	0.0161	0.0003
Surgical preparation (4.1)	0.1281	0.0441
Total parenteral nutrition (TPN) administration: adult (3.4)	0.0033	
Aspiration precautions (3.2)	0.0233	
Anger control assistance (2.8)	0.0177	
Mood management (2.5)	0.0091	0.0004
Self-care assistance (2.2)	0.1323	
Procedure preparation (2.1)	0.1079	
Dementia management (1.6)	0.0816	
Electroconvulsive therapy (1.6)	0.0290	
Cast care: maintenance (1.1)	0.0035	0.0037
Splinting (1.1)	0.0086	
Music therapy (1.1)	0.0036	0.0019
Medical immobilization (0.9)	0.0356	

primary medical diagnosis of the three inversely associated with experiencing an adverse incident (O.R. = 0.43), indicating that hospitalizations with this medical diagnosis were less likely to suffer an adverse incident compared to hospitalizations that did not have this condition. O*ther primary cancer* and *senility and organic mental disorders* were both positively associated with experiencing an adverse incident with odds ratios of 1.94 and 1.57, respectively.

Severity of illness, although not significant in step three, was entered into the final model for risk adjustment [17]. *Severe* and *major* severity of illness categories were significantly ($P \leq 0.05$) and positively associated with

Table 3: Final model for the explanatory variables of experiencing an adverse incident.

Variable names	Estimate	Standard error	*P* value	Odds ratio	95% C.I.	
Patient characteristics						
Age at admission	−0.0001	0.00375	0.9735	1.000	0.993	1.007
Clinical conditions						
Primary medical diagnoses						
Other nervous system disorders	−0.8502	0.3623	0.0189	0.427	0.210	0.869
Cancer, other primary	0.6602	0.1957	0.0007	1.935	1.319	2.840
Senility and organic mental disorders	0.4532	0.1704	0.0078	1.573	1.127	2.197
Severity of illness						
Severe/extreme	0.3116	0.1530	0.0417	1.366	1.012	1.843
Major	0.2795	0.1379	0.0427	1.322	1.009	1.733
Moderate (*mild is reference category)*	0.1513	0.1355	0.2644	1.163	0.892	1.517
Past hospitalizations						
Four or more previous hospitalizations	−0.1976	0.2580	0.4437	0.821	0.495	1.361
Three previous hospitalizations	−0.0810	0.2460	0.7419	0.922	0.569	1.494
Two previous hospitalizations	−0.1733	0.1625	0.2864	0.841	0.611	1.156
One previous hospitalization (*no previous hospitalizations is reference)*	0.0133	0.0888	00.8809	1.013	0.852	1.206
Context of Care						
Average CGPR RN for Hospitalization (mean RN HPPD = 9.47) [Best Staffing]	−0.2817	0.1002	0.0049	0.755	0.620	0.918
Average CGPR RN for hospitalization (mean RN HPPD = 6.64)	−0.4737	0.1007	<0.0001	0.623	0.511	0.758
Average CGPR RN for hospitalization (mean RN HPPD = 5.56)	−0.0861	0.0917	0.3480	0.918	0.767	1.098
Average CGPR RN for hospitalization (mean RN HPPD = 4.07) [worse staffing]						
CGPR RN dip proportion	0.6771	0.2647	0.0105	1.150 (per 0.2 increments)	1.172	3.307
Treatments						
Medical treatments						
Number of medical treatments	0.0279	0.0140	0.0460	1.028	1.000	1.057
Physical therapy	0.4192	0.1307	0.0013	1.521	1.177	1.965
Pharmacy treatments						
Number of unique medications	0.0431	0.00438	<0.0001	1.044	1.035	1.053

Table 3: Continued.

Variable names	Estimate	Standard error	*P* value	Odds ratio	95% C.I.	
Succinimides	0.2175	0.0707	0.0021	1.243	1.082	1.428
Caloric agents	0.2002	0.0792	0.0115	1.222	1.046	1.427
Ammonia detoxicants	−0.4192	0.1811	0.0206	0.658	0.461	0.938
EENT anti-infectives	0.1705	0.0730	0.0195	1.186	1.028	1.368
Nursing treatments						
Pressure ulcer care						
High use (68–100%) 0.92 use rate	0.00989	0.1555	0.9493	1.010	0.745	1.370
Medium use (34–67%) 0.41 use rate	0.3385	0.1390	0.0149	1.403	1.068	1.842
Low use (1–33%) 0.25 use rate	0.3472	0.1361	0.0107	1.415	1.084	1.848
Health screening						
High use (68–100%) 0.72 use rate	−0.2464	0.1366	0.0713	0.782	0.598	1.022
Medium use (34–67%) 0.21 use rate	−0.0938	0.0969	0.3332	0.910	0.753	1.101
Low use (1–33%) 0.08 use rate	0.2803	0.0776	0.0003	1.323	1.137	1.541
Neurologic monitoring						
High use (68–100%) 7.56 use rate	−0.1478	0.1462	0.3119	0.863	0.648	1.149
Medium use (34–67%) 4.46 use rate	0.0110	0.1308	0.9328	1.011	0.782	1.306
Low use (1–33%) 1.96 use rate	0.4180	0.1062	<0.0001	1.519	1.234	1.870
Blood products administration						
High use (68–100%) 3.70 use rate	−0.1061	0.1847	0.5657	0.899	0.626	1.292
Medium use (34–67%) 0.89 use rate	0.4029	0.1465	0.0060	1.496	1.123	1.994
Low use (1–33%) 0.17 use rate	0.1758	0.1498	0.2405	1.192	0.889	1.599
Restraint						
High use (68–100%) 16.47 use rate	0.7698	0.1554	<0.0001	2.159	1.592	2.928
Medium use (34–67%) 4.79 use rate	0.6229	0.1471	<0.0001	1.864	1.397	2.487
Low use (1–33%) 1.19 use rate	0.4595	0.1423	0.0012	1.583	1.198	2.092
Specimen management						
High use (68–100%) 1.68 use rate	−0.1680	0.2255	0.4564	0.845	0.543	1.315
Medium use (34–67%) 0.34 use rate	0.3912	0.1879	0.0374	1.479	1.023	2.137
Low use (1–33%) 0.10 use rate	0.4334	0.1767	0.0142	1.543	1.091	2.181
Active listening 1.79 use rate	0.4895	0.1385	0.0004	1.631	1.244	2.140
Mood management 3.09 use rate	0.6080	0.1748	0.0005	1.837	1.304	2.587
Cast care maintenance 5.31 use rate	0.6905	0.2335	0.0031	1.995	1.262	3.153
Music therapy 0.21 use rate	0.7102	0.2287	0.0019	2.034	1.300	3.185

experiencing an adverse incident compared to the lowest severity of illness category (i.e., mild) (see Table 3).

Seven comorbid conditions were retained from step two for inclusion in step three but none were significant and thus were not retained for inclusion in the final model. Past hospitalizations during the study period were significant in step two but not in step three (see Table 2). However, this variable was entered into the final model to adjust for patients that had experienced more than one hospitalization during the study period. In the final model (Table 3) past hospitalizations were not significant.

Four context of care variables, the *number of units the patient resided on during hospitalization*, the *dip proportion (falling below the unit's average staffing)*, *skill mix*, and the *average Caregiver Patient Ratio (CGPR)* [14], were significant in step two (see Table 2) but only two variables, the *dip proportion* and *average CGPR,* were significant in step three and retained for the final model (see Table 2). Both were significant in the final model (step four) as illustrated in Table 3. The *average CGPR* (RN hours per patient day (HPPDs)) was categorized as quartiles to enable comparison and interpretation for this nonlinear variable. The two highest *average CGPR* quartiles (9.5 RN HPPDs and 6.6 RN HPPDs) were significantly ($P \leq 0.05$) and inversely associated with experiencing an adverse incident, indicating that when compared to the lowest quartile of staffing (4.1 RN HPPDs), the odds of experiencing an adverse incident decreased in the highest two quartiles of nursing hours per patient day. The odds of experiencing an adverse incident for hospitalizations with the highest *average CGPR* quartile (9.5 RN HPPDs) were 0.76 of the odds for hospitalizations that experienced the lowest *average CGPR* quartile (4.1 RN HPPDs). The odds of experiencing an adverse incident for hospitalizations with the second highest *average CGPR* (6.6 RN HPPDs) were 0.62 of the odds for hospitalizations in the lowest *CGPR average* quartile.

The CGPR dip proportion was significantly ($P = 0.011$) and positively associated with experiencing an adverse incident. The results shown in Table 3 are in terms of 0.2 increments of change and indicate that for each 20% fall in staffing below the average, the odds of experiencing an adverse incident increase by 15% (O.R. = 1.15).

The number of medical treatments received during hospitalization and 20 types of medical treatment were significant in step two (see Table 2) and were therefore included in step three. In step three of the analysis, the number of medical treatments received during hospitalization and one medical treatment type, *physical therapy*, were significant ($P \leq 0.05$) and retained for the final model. Both were positively associated with experiencing an adverse incident (see Tables 2 and 3). The results indicate that for each additional medical treatment received during hospitalization, the odds of experiencing an adverse incident increased by approximately 3% (O.R. = 1.03). Hospitalizations that received the medical treatment *physical therapy* were 52% (O.R. = 1.52) more likely to experience an adverse incident than hospitalizations that did not receive this medical treatment.

The number of unique medications received during hospitalization and 27 specific pharmaceutical treatments (i.e., medications types) were significant in step two of the analysis ($P \leq 0.15$) and thus retained for step three. The number of unique medication types and four types of medications were significant in step three (see Table 2) and all were significant in the final model (see Table 3). The number of unique medications was positively associated ($P < 0.001$) with experiencing an adverse incident (O.R. = 1.04). Receipt of *succinimides, caloric agents,* and *EENT anti-infectives* during hospitalization increased the odds of an adverse incident. *Ammonia detoxicants* were inversely associated ($P = 0.021$) with experiencing an adverse incident (O.R. = 0.46).

In step two of the analysis, the number of unique nursing treatments received during hospitalization was not significant but 38 types of nursing treatments were significant ($P \leq 0.15$) and entered into step three (see Table 2). Eleven were significant at step three and ten were significant in the final model (see Tables 2 and 3). *Surgical preparation* was not significant in the final model. The nursing treatment *pressure ulcer care,* received by 91.5% of the sample, was divided into thirds based on the average number of times per day it was delivered (see Table 1). The results for the three categories of use are interpreted in comparison to hospitalizations that did not receive the nursing treatment. The middle and low use categories of *pressure ulcer care* were significantly ($P \leq 0.05$) and positively associated with experiencing an adverse incident, indicating that hospitalizations that received *pressure ulcer care* a little less than once every other day (use rate = 0.41) or once every four days (use rate = 0.25) were more likely to experience an adverse incident than hospitalizations that did not receive *pressure ulcer care.* A similar pattern emerged with the nursing treatment of *specimen management.* The medium (use rate = 0.34) and low (use rate = 0.10) categories were significantly ($P \leq 0.05$) and positively associated with experiencing an adverse incident (see Table 3).

Both *health screening* and *neurologic monitoring* had low use categories that were significantly ($P \leq 0.05$) and positively correlated with experiencing an adverse incident. The results indicate that hospitalizations that received the low use of these two nursing treatments were more likely to experience an adverse incident than hospitalizations that did not receive the associated nursing treatment (see Table 3).

The medium use category of *blood products administration* (use rate = 0.89) was significantly ($P \leq 0.05$) and positively (O.R. = 1.49) associated with experiencing an adverse incident. Hospitalizations that received *Blood Products Administration* a little less than once a day were almost 50% more likely to experience an adverse incident than hospitalizations that did not receive *blood products administration.*

All three categories of use for the nursing treatment *Restraint* were significantly ($P < 0.01$) and positively associated with experiencing an adverse incident (see Table 3). The high use category had an average delivery of 16.47 times a day and hospitalizations that received high use of *restraint* had more than double the odds (O.R. = 2.16) of experiencing an adverse incident compared to hospitalizations that did

not receive this nursing treatment. Hospitalizations that received *restraint* approximately four and a half times a day (medium use category) had almost double the odds (O.R. = 1.86) of experiencing an adverse incident compared to hospitalizations that did not receive *restraint*. The lowest category of use was delivered an average a little more than once a day and increased the likelihood of experiencing an adverse incident by 58% (O.R. = 1.58) compared to no use.

The remaining significant nursing treatments were delivered to less than 5% of the sample and were therefore operationalized as dichotomous variables so that hospitalizations that received the nursing treatment at least once are compared to hospitalizations that did not receive the treatment (see Table 1 for definition). *Active listening* received at least once by 4.8% of the sample was significantly ($P < 0.001$) and positively (O.R. = 1.63) associated with experiencing an adverse incident.

Mood management was received by only 2.5% of the sample but was delivered an average of 3.1 times per day when it was delivered. Hospitalizations that received *mood management* almost doubled their odds (O.R. = 1.84) of experiencing an adverse incident compared to hospitalizations that did not receive *mood management*.

Cast care maintenance was another nursing treatment that was delivered frequently (more than five times a day on average) when hospitalizations required it. Receiving this nursing treatment doubled the odds (O.R. = 2.00) of experiencing an adverse incident compared to hospitalizations that did not receive this nursing treatment.

Slightly more than one percent of the sample received the nursing treatment *music therapy*. The average use rate for hospitalizations that received this treatment was slightly more than once every ten days (use rate = 0.21). The odds of experiencing an adverse incident were double (O.R. = 2.03) for hospitalizations that received this nursing treatment compared to hospitalizations that did not receive *music therapy* (see Table 3).

6. Discussion

None of the patient characteristics were significant, indicating that patient characteristics were not explanatory variables of adverse incidents, given the other variables that entered the model. Also nonsignificant were two clinical conditions: number of past hospitalizations during the study period and comorbid medical conditions. This indicates that after controlling for other variables in the model, patient characteristics of this sample of older adults were not significant for experiencing an adverse incident during hospitalization.

Three primary medical diagnoses were significant explanatory variables associated with experiencing an adverse incident. *Other nervous system disorders* were inversely associated with experiencing an adverse incident. This inverse relationship may be explained by considering the type of nursing unit these patients are typically admitted to. A primary medical diagnosis of *nervous system disorder,* which is composed of peripheral and central nervous system disorders along with more generic symptoms of a nervous system disorder [11], would likely warrant admission to a neurology unit in this academic medical setting where the nursing personnel are skilled in the care of these patients and may recognize the need for increased surveillance. This heightened surveillance for these specialized patients may decrease adverse incidents.

Other primary cancer was positively associated with experiencing an adverse incident. Patients hospitalized with the primary medical diagnosis of *other primary cancer* are on high-risk medications, some that call for double-checks, and that may increase the number of medication errors that are discovered. The third primary medical diagnosis, *senility and organic mental disorders,* appears similar in nature to *other nervous system disorders* but is positively associated with experiencing an adverse incident, unlike *other nervous system disorders*. This may be because patients who have *senility and organic mental disorders* are less capable of using safety equipment in their environment like call lights and hand rails and are more likely to be dispersed among a variety of general medical or surgical units. The environment and specialized nursing expertise may not be readily available to meet the unique care demands of individuals with this primary medical condition. In the final model, the top two severities of illness categories (i.e., severe and major) were significantly and positively associated with experiencing an adverse incident. This is not surprising, as patients who are sicker often have complex care issues which may place them at greater risk to experience an adverse incident.

Related to the structure of care (context of care), the two highest categories of the *average CGPR* (RN HPPDs) were significantly and inversely associated with experiencing an adverse incident compared to the lowest quartile, indicating that when there are more nursing hours per patient day, there is a decreased likelihood of preventing an adverse incident. This is consistent with findings from previous research [18–24].

The *CGPR RN dip proportion* was positively associated with adverse incidents. The more the RN staffing fell below the nursing unit average, the more likely an adverse incident was to occur during that hospitalization. This finding indicates that not only is the number of nurses, or HPPDs, an important predictor of adverse incidents but so is staffing below the average on a nursing unit. This may indicate that units develop effective processes dependent upon their average staffing and when the staffing is altered, the processes are impacted. Staffing below the unit average places the patient at greater risk for having an adverse incident

Processes of care included medical, pharmaceutical, and nursing treatments. Both the number of medical treatments and the number of unique medications received during hospitalization were positively associated with experiencing an adverse incident. As the number of procedures and medications increased so did the odds of having an adverse incident (e.g., medication error, wrong site surgery, trauma, etc.).

There was one medical treatment, *physical therapy,* and two medication types, *succinimides* and *ammonia detoxicants,* that were significantly associated with experiencing an adverse incident, which may be related to falls. The positive association between *physical therapy* and adverse

incidents may be a reflection of patients with decreased functional status who are at greater risk for falling. Similarly, s*uccinimides* are anticonvulsives and are in the same AHFS class as *barbiturates* and *benzodiazepines* [9], which are positively associated with falls [25]. *Ammonia detoxicants* was the only pharmaceutical treatment in the final model inversely associated with experiencing an adverse incident (see Table 3). Patients who require *ammonia detoxicants* often have conditions associated with liver dysfunction, which makes it more difficult for them to excrete ammonia that builds up in their body. Patients that have high ammonia levels are often confused, disoriented, difficult to direct, and are at great risk for falling for these reasons.

The nursing treatments associated with adverse incidents were diverse. There was one nursing treatment, *pressure ulcer care*, that is used to treat an adverse incident (i.e., pressure ulcer). There were also a number of nursing treatments positively associated with adverse incidents where providing the treatment showed that the patient likely had greater exposure to an adverse incident than patients who did not receive the treatment. One example is the nursing treatment *specimen management* where a patient is more likely to have a mislabeled lab as an adverse incident than a patient who did not receive this treatment. The same could be true for *blood product administration* and *cast care maintenance*.

Similarly, all three categories of *Restraint* were significantly and positively associated with experiencing an adverse incident. Only 8.5% of the hospitalizations in this sample received *restraint* at least once but the use rates were relatively high, especially the high use category with an average delivery of 16.47 times per day. These findings also show that use of restraints does not prevent adverse incidents (e.g., falls) and in fact may contribute to them as has been demonstrated in other research [26, 27].

Active listening, mood management, and *music therapy* may be used as complementary therapies for patients who are distressed, confused, or combative when other treatments have not worked. Hospitalizations that require these nursing treatments may be at greater risk for falling because the patient is unable to follow commands, is impulsive or unable to communicate effectively.

7. Limitations

This study was conducted at one academic medical center and therefore further multisite research is needed. Although the effectiveness research model used in this study includes many important, patient and multidisciplinary components, there were important aspects of care that impact patient safety such as the individual characteristics of the clinicians involved in care (e.g., experience, education) and how they interact with one another (e.g., teamwork, communication) that were not included in this study [28].

8. Conclusion

This study examined a number of patient conditions, structural variables, and process of care variables to better understand what factors contribute to adverse incidents during hospitalization. This is one of the first studies to show that delivered nursing treatments help explain adverse incidents in hospitalized, older adults. This study also used a multidisciplinary model that considered medical and pharmaceutical components of treatment, which are critical when providing care of the older adult in acute care. With this more robust multidisciplinary model, RN staffing was still an important explanatory variable for adverse incidents, which is congruent with findings from other research [29, 30].

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Research Article

The Impact of Nursing Characteristics and the Work Environment on Perceptions of Communication

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Failure to communicate openly and accurately to members of the healthcare team can result in medical error. The purpose of this study was to explore the impact of nursing characteristics and environmental values on communication in the acute care setting. Nurses ($n = 135$) on four medical-surgical units in two hospitals completed a survey asking nurses' perceptions of communication, work environment, and nursing demographics. LPNs perceived significantly higher levels of open communication with nurses than did RNs ($P = .042$). RNs noted higher levels of accuracy of communication among nurses than did LPNs ($P < .001$). Higher experience levels resulted in greater perceptions of open communication. Only environmental values (e.g., trust, respect) were a significant predictor of both openness and accuracy of communication. These findings suggest understanding the environment (e.g., presence or absence of trust, respect, status equity, and time availability) is a foundational step that must occur before implementing any strategies aimed at improving communication.

1. Introduction

A significant cause of medical error in health care is poor communication [1, 2]. For the past three years, miscommunication has been identified as one of the most frequently identified root causes of sentinel events reported to The Joint Commission, with 82% of the sentinel events in 2010 identifying communication as the primary root cause [3]. According to Rucker and colleagues, up to 75% of clinical decisions are made without all pertinent clinical information [4]. Differences in status and discipline may be part of the confounding factors associated with poor communication. This includes various job categories (supervisor/supervisee), expertise level (novice/expert), and discipline (doctor/nurse) [2].

Although variations in status and discipline are abundant in the healthcare environment, it is critical for all members of the healthcare team to communicate effectively with one another, despite these differences. In an effort to understand how status and discipline differences may impact perceptions of communication, the purpose of this study was to explore the impact of nursing characteristics (e.g., job category, education, experience, and expertise) on perceptions of communication in the acute care setting, while also considering the impact of the work environment.

2. Literature Review

The act of communication between nurses and physicians is a central activity in healthcare, and a failure to communicate has been linked with poor quality and patient errors [5]. Effective communication and collaboration among nurses and physicians has been shown to result in improved quality of care [6, 7], increased patient and professional satisfaction [6, 8], and greater intent to stay [8, 9]. Specifically, the presence of poor communication among nurses and physicians may result in an almost doubled risk for mortality and length of stay among intensive care unit (ICU) patients [8, 10, 11]. Manojlovich and colleagues, while surveying nurses in 25

ICUs, found timeliness of communication to be inversely correlated with pressure ulcer development ($r = -.38$, $P = .06$) [12]. In addition, higher variability of understanding—which can occur with a variety of education and experience levels—was significantly correlated with ventilator associated pneumonia ($r = .43$, $P = .03$).

Current research evaluating the impact of nursing characteristics on communication has resulted in mixed findings. Miller and colleagues, while examining the presence of individual characteristics and perceptions of nurse-physician interactions, found nurses with greater than six years of experience rated openness of communication and problem solving higher than less experienced nurses ($P = .04$) [13]. Foley and colleagues found a significant relationship between nurse-physician relationships and nursing expertise and the number of professional certifications ($P = .05$) [14]. In contrast, Mark and colleagues evaluated the relationship between nurse staffing, professional practice, and several patient outcomes and found no significant relationship between nurse staffing variables (education, experience, and skill mix) and professional practice [15].

Although nursing characteristics such as education and expertise level may determine levels of communication and collaboration (i.e., physicians may respect nurses who are more educated), values supported in the environment in which care is delivered may also impact communication patterns. When the values of the organization include trust, respect, and teamwork, collaborative relationships are more likely to ensue. According to Schmalenberg and colleagues, who conducted interviews with physicians and nurses, environmental values play a role in fostering the development of effective communication/collaboration [16]. One interviewee described collaboration as "a prevailing unit and organizational norm based on mutual trust, respect, teamwork, and open communication." Findings from focus groups of nurses and physicians conducted by Simpson and colleagues identified an agreement among participants that many interactions and experiences with one another over time were the basis for trust and confidence in one another [17].

In summary, communication among the healthcare team is critical for optimal patient outcome. The current literature has failed to identify specific communication strategies that have consistently impacted quality of care and patient safety [18]. This may be due to the failure to consider individual characteristics, such as education, experience, and expertise levels, as well as the values present in the environment. In addition, little work has been done beyond the critical care areas—ICUs, emergency rooms, and operating rooms. For this reason, the purpose of this study was to identify the relationship between individual nursing characteristics (education, experience, expertise, and job type), environmental values, and perceptions of communication with the healthcare team in the acute care setting.

3. Methods

3.1. Design. This study used a cross-sectional, descriptive design with a convenience sample of four in-patient medical surgical units in two Midwestern hospitals. All nurses employed on the units providing direct patient care were asked to participate. Nurses who did not perform direct patient care were excluded. A total of 161 registered nurses (RNs) and 18 licensed practice nurses (LPNs) were eligible for study participation. Based on a power analysis (multiple regression with 11 predictors) with an α of 0.05, medium effect size ($f^2 = .15$), and power ($1 - \beta$) = .80, 123 respondents were needed for the analysis. The number of questionnaires returned was 135, with response rates for the units ranging from 69% to 82% (overall response rate of 76%). Approval for the study was obtained from the institutional review board for each institution.

3.2. Data Variables and Survey Instrument. The survey tool used to identify perceptions of communication was a modified version of Shortell's Organizational Management in the Intensive Care Unit Survey [19]. The entire survey included 44 questions asking nurses' perceptions of communication, collaboration, the environmental values present in their respective units, as well as nursing demographic information. For the purpose of this study, the questions regarding communication, environmental values, and nursing demographics were used.

3.2.1. Communication. Communication was measured by two dimensions: openness and accuracy. Communication openness refers to "the degree to which physicians or nurses are able to 'say what they mean' when speaking with members of the other group, without fear of repercussions or misunderstanding" [19, page 712]." Four questions on the survey instrument addressed the openness of communication among nurses and four additional questions considered the openness of communication between nurses and physicians. Each item was measured by a 7-point Likert scale with anchors 1 (strongly disagree) to 7 (strongly agree). Communication accuracy refers to the "degree to which nurses and physician believe in the accuracy of the information conveyed to them by the other party [19]." Four questions on the survey instrument addressed the accuracy of communication among nurses and four additional questions considered accuracy of communication between nurses and physicians. Each item was measured by a 7-point Likert scale (1, strongly disagree, to 7, strongly agree). Validity and reliability of the instrument had been previously reported [19]. Reliability estimations in this study also supported consistency in the items: open communication among nurses ($\alpha = 0.89$) and between nurses and physicians ($\alpha = .92$), accuracy of communication among nurses ($\alpha = .79$) and between nurses and physicians ($\alpha = .84$).

3.2.2. Nursing Characteristics. Nursing characteristics included in this study were education, years of experience, and self-reports of expertise. Level of education was measured categorically with the following options being present: diploma, associate's degree, bachelor's degree master's degree, or higher. Nursing experience was measured through a single-item question: How many years have you been

Table 1: Homogeneity test by unit characteristics (n = 135).

	Unit A M (SD)	Unit B M (SD)	Unit C M (SD)	Unit D M (SD)	F/χ^2	P
Experience as nurses (years)	15.86	12.81	8.37	11.24	2.741	.046
Expertise level	7.28	7.02	6.79	6.76	.490	.690
Educational level	N (%)	N (%)	N (%)	N (%)		
Diploma/Associate	23 (57.5)	16 (48.5)	18 (56.3)	16(55.2)	.671	.880
BSN and over	17(42.5)	17(51.5)	14 (43.8)	13 (44.8)		

working in your current job category? The final measure of nursing expertise required the nurses to identify their perceived level of expertise on a 10-point scale with anchors novice (1) to expert (10). Respondents were asked to circle the number on the scale that best reflects his/her level of expertise. Other nursing characteristics included in the study were job category (e.g., LPN or RN), unit of employment, and shift worked (e.g., day, evening, night, or rotating).

3.2.3. Environmental Values. The previous literature has identified environmental values as important precursors to the development of effective communication and collaborative relationships, including trust, respect, power equity, and time availability. Questions related to each of these values was developed and measured by a single question on a 7-point Likert scale with anchors strongly agree (1) to strongly disagree (7). Data from this study supported a highly positive correlation between the four factors, as noted by the following correlation values: trust and respect (r = .82), trust and time (r = .54), trust and status (r = .67), respect and time (r = .60), respect and status (r = .66), and finally time and status (r = .62) (P = .001 for each bivariate association). This supported the development of an overall environmental value variable, which was the combined average of each of the unit value items (per nurse). Reliability estimation for the environmental value variable was considered well above the acceptable range (α = 0.88).

3.3. Procedure. Prior to distribution of the survey, nurses were presented with a 10-minute overview of the study. This overview was given to each unit at four different times of the day, in an effort to attain maximum participation. Upon completion of the in-service, each nurse received a copy of the survey. A reminder was placed in each nurse's mailbox two weeks after the initial survey distribution in an effort to increase response rate. A secure box was also placed in the nursing lounge of each unit for completed surveys.

3.4. Analysis. Data were analyzed with SPSS 18.0. Descriptive statistics were used to examine the demographics of nurses; analysis of variance (ANOVA) and chi-square tests were performed to test homogeneity of unit characteristics. To identify the difference in communication between nursing characteristics, t-tests were performed. Hierarchical multiple regression analysis was conducted to identify predictors of openness and accuracy of communication. A test for multicollinearity was conducted using tolerance and VIF; no multicollinearity was identified. Residual analysis identified a normal distribution, linearity of residual, and homoscedasticity of errors. A significant value below 0.05 was considered statistically significant.

4. Findings

Nursing respondents (n = 135) were split nearly equally between Hospital A (n = 74, 55%) and Hospital B (n = 61, 45%). The majority of the nurses were RNs (n = 119, 88%) while 15 were LPNs (11%). Seventy-three (54.1%) nurses had earned an associate/diploma degree and 58 (43%) had a baccalaureate degree. Sixty-eight nurses worked the day shift and 43 nurses worked the night shift. Work experience as nurses was on average 12.30 years, ranging from 6 weeks to 46 years. Self-rating of expertise level was 6.98, with a range of 1 (novice) to 10 (expert).

Comparisons of nurse educational level, work experiences, and expertise levels by study units revealed no difference in educational level and expertise level (Table 1). A significant difference in work experiences was noted, with Unit A having the highest work experiences as nurses, followed by Unit B (P = .046).

4.1. Differences in the Perception of Communication. As noted in Table 2, nurses (e.g. RNs and LPNs) perceived communication to be more open among nurses than between nurses and physicians (t =10.227, P < .001). However, nurses perceived that communication was more accurate with physicians than with nurses (t = 2.18, P = .031).

When comparing openness and accuracy of communication between job category (e.g., RN and LPN) (Table 2), LPNs perceived significantly higher levels of open communication with nurses than did RNs (P = .042). In contrast, RNs noted higher levels of accuracy of communication among nurses than did their LPN counterparts (P < .001). No significant difference between LPNs and RNs was noted in openness and accuracy of communication with physicians.

4.2. Predictors of Openness of Communication. Hierarchical multiple regression analysis was conducted to identify the variables which predicted openness of communication (Table 3). Individual nursing characteristics were entered in Step 1, explaining 8.4% of the variation in open communication among nurses (nonsignificant). After entry of the

Table 2: Differences in openness and accuracy of communication.

(a)

	Within nursing Mean (SD)	Between DR and RN Mean (SD)	t	P
Open communication	5.74 (1.00)	4.45 (1.30)	10.227	.000
Accuracy of communication	2.68 (.80)	2.82 (.91)	2.18	.031

(b)

	RN (n = 119) M (SD)	LPN (n = 135) M (SD)	t	P
Open communication with nurses	5.75 (1.01)	6.32 (0.7)	−2.051	.042
Open communication with physicians	4.44 (1.30)	4.60 (1.48)	−.432	.667
Accuracy of communication with nurses	3.29 (0.59)	2.56 (0.4)	4.542	.000
Accuracy of communication with physicians	3.28 (0.65)	3.04 (0.51)	1.350	.179

Table 3: Hierarchical multiple regression analysis predicting openness of communication (n = 135).

	Open communication among nurses				Open communication between nurses and physicians			
	β	$t(P)$	β	$t(P)$	β	$t(P)$	β	$t(P)$
Constant	5.542	.000	4.983	.000	3.007	.000	0.361	.375
LPN(RN = 0)	0.637	.042	0.325	.245	0.141	.724	−0.47	.072
Education	0.14	.419	0.018	.908	0.454	.049	0.189	.197
Nights(day = 0)	0.021	.914	−0.098	.572	0.033	.897	−0.119	.475
Evenings	−0.49	.087	−0.473	.061	−0.315	.400	−0.477	.048
Rotating	−0.6	.137	−0.213	.553	0.052	.922	−0.036	.916
Expertise	0.006	.917	0.001	.982	0.08	.302	−0.029	.569
Experience	0.009	.891	−0.035	.567	0.071	.425	0.125	.035
Environment			0.274	.000			0.797	.000
Unit B (Unit A = 0)			0.13	.537			0.088	.659
Unit C			−0.594	.009			0.397	.064
Unit D			−0.578	.011			0.493	.022
$F(P)$	1.580 (.148)		5.225 (.000)		1.481 (.180)		19.396 (.000)	
R^2	.084		.331		.079		.646	
$\triangle R^2$	.084		.247		.079		.567	

unit and environmental value variables (Step 2), the total variance explained by the model was 33.1% (F = 5.25, P < .001). Only environmental values (P < .001) and unit (P = .009 and P = .011) were significant predictors of open communication among nurses. Specifically, the more positive the environmental values (e.g., high trust, respect, etc.), the greater the perception of communication openness among nurses. In addition, unit was a significant predictor, such that nurses on Units C and D noted lower levels of communication openness than the referent group (Unit A).

A second analysis, with dependent variable open communication between nurses and physicians, was computed with independent variables job category, education, shift, experience, and expertise entered in Step 1. Only education level was predictive of open communication between nurses and physicians. Specifically, higher education levels were associated with greater perceptions of communication openness with physician colleagues. In Step 2, the environmental values and unit variables were entered (Table 3). The final model explained 64.6% of the variance (F = 19.396, P < .001). The significant predictors of open communication with physician included the evening shift (P = .048), years of experience as a nurse (P = .035), environmental values (P < .001), and unit (unit 4, P = .022). Education levels were

Table 4: Hierarchical multiple regression analysis predicting accuracy of communication ($n = 135$).

	Accuracy communication among nurses				Accuracy communication between nurses and physicians			
	β	$t(P)$	β	$t(P)$	β	$t(P)$	β	$t(P)$
constant	2.385	.000	2.952	.000	2.798	.000	3.34	.000
LPN (RN = 0)	−0.994	.000	−0.801	.001	−0.217	.416	0.007	.977
Education	−0.059	.663	0.024	.855	−0.055	.721	0.058	.678
Nights (Day = 0)	0.493	.002	0.549	.000	0.562	.001	0.647	.000
Evenings	0.295	.184	0.311	.142	0.408	.104	0.4	.080
Rotating	0.693	.027	0.577	.057	1	.005	0.724	.028
Expertise	0.03	.520	0.044	.319	−0.025	.629	−0.016	.744
Experience	−0.02	.705	−0.008	.880	−0.009	.883	0.024	.675
Environment			−0.202	.000			−0.241	.000
Unit B (unit A = 0)			−0.098	.583			−0.116	.544
Unit C			0.121	.517			0.375	.065
Unit D			0.1	.600			0.399	.055
$F(P)$	5.026 (.000)		5.345 (.000)		2.790 (.010)		5.235 (.000)	
R^2	.231		.342		.141		.334	
ΔR^2	.231		.111		.141		.193	

no longer a significant predictor. Nurses working the evening shift perceived lower openness of communication compared to day shift nurses. Nurses with more years of experience noted higher levels of openness in communication ($B = .125$, $P = .035$). In addition, a more positive environment was predictive of greater openness in communication ($B = .797$, $P < .001$).

4.3. Predictors of Accuracy of Communication. Hierarchical multiple regression analysis was also used to identify the variables which predicted accuracy of communication (Table 4). Individual nursing characteristics entered in Step 1 explained 23% of the variance in accuracy of communication among nurses ($F = 5.03$, $P < .001$). An additional 11.1% of variation was explained with the inclusion of the unit and the environmental value variables entered in Step 2. The final model ($F = 5.345$, $P < .001$) explained 34.2% of the variance in accuracy of communication (among nurses). Job category (e.g., LPN) ($P = .001$), shift ($P < .001$) (e.g., night), and environmental values ($P < .001$) were significant predictors. Specifically, LPNs perceived less accuracy in communication among the nursing staff than their RN counterparts. Nurses working night shift identified greater accuracy in communication than their day shift colleagues. A more positive environment was associated with less accuracy in communication among nurses.

Another analysis, with dependent variable accuracy of communication between nurses and physicians, was computed with the following independent variables: job category, education, shift, expertise, years of experience, environmental values, and unit. The first model (Step 1) included the nursing characteristics variables and explained 14.1% of the variance in the dependent variable ($F = 2.80$, $P = .01$). The unit and environmental values variables, entered in Step 2, explained an additional 19.3%, for a total of 33.4% of variance explained ($F = 5.235$, $P < .001$). Significant predictors included shift (night, $P < .001$, and rotating, $P = .028$) and environmental values ($P < .001$). Specifically, nursing staff working night and rotating shifts identified greater accuracy in communication between nurses and physicians than did day shift nurses. In addition, a work environment with greater trust, respect, time, and status equity was predictive of lower accuracy of communication between nurses and physicians ($P < .001$).

5. Discussion

This study sought to identify the relationship between individual nursing characteristics and perceptions of communication with the healthcare team. Findings revealed a significant relationship between some of these variables. Overall, nurses (both RNs and LPNs) reported greater openness among nurses than between nurses and physicians. In contrast, they reported communication between nurses and physicians to be more accurate than among the nursing team.

Significant variation in perceptions of openness and accuracy of communication were identified between RNs and LPNs. RNs identified significantly more accurate communication among nurses whereas LPNs identified significantly greater communication openness. This may in part be related to the role expectations of the LPN and RN. The LPN, due to licensure restrictions, must be assigned to an RN, and therefore frequent interaction among the nurse dyad (RN-LPN) is required. Due to an increase in interactions with RNs, LPNs may note greater inaccuracies in communication among the team. RNs—in contrast to LPNs—can work

autonomously due to his/her greater scope of practice, and therefore, do not rely on communication from others to determine patient care needs.

Experience level was also predictive of communication. Specifically, years of experience of the nurse was significantly related to openness of communication among nurses and physicians. This may be in part due to the need for frequent interaction for antecedents of effective communication, including trust and respect, to develop [17]. Also, nurses with greater years of experience may be viewed as having greater expertise among physician colleagues, especially in an acute care environment where physician colleagues may rotate monthly. Higher levels of education were associated with greater perceptions of nurse-physician communication, but when the environment was considered, this was non-significant. This sheds some light on the importance of the context of the environment.

Unit of employment was predictive of openness and accuracy of communication. This may be related to the fact that Unit C and D had the lowest average for years of experience and self-reported expertise, which was shown to predict openness in communication between nurses and physicians. Nurse shift was also significantly associated with perceptions of communication openness and accuracy. Specifically, night shift nurses identified greater levels of accuracy of communication among nurses, and between nurses and physicians compared to nurses on the day shift; in contrast, evening shift nurses identified lower levels of communication openness than the day shift. These findings may be related to the presence of physicians on these shifts. At night, less staff (both nursing and medical) are present, which may result in a greater need to work together to ensure optimal care delivery; communication must be more accurate for timely implementation of appropriate interventions.

The values present in the environment were predictive of all four outcome variables (e.g., openness/accuracy of communication among and between nurses and physicians). As expected, when positive values, such as trust, respect, and status equity, are present on the environment, openness in communication among the healthcare team ensues. This finding is similar to other studies [16, 17] which have noted the impact of these variables on effective communication. Work environments that foster trust, respect, status equity, and time availability create an atmosphere were communication can flourish. Interestingly, the same values that fostered open communication seem to reduce accuracy in communication. According to the study findings, greater presence of the work environment values was associated with less accuracy in communication. One potential reason for this may be that staff working in a positive environment (e.g., trust and respect present) is more willing to state their opinions about patient care needs; Jones and George found trust among team members fostered greater willingness to share information freely among the team [20]. In contrast team members who do not feel valued or believe information may be used inappropriately are less willing to share pertinent information [21]. In such an environment (e.g., low trust and respect), staff may be less likely to share their thoughts, and instead state only facts that are fully supported.

There are two noteworthy limitations of this study. The data for this study came from four acute care units located in one of two Midwestern Hospitals, thus generalizability is limited to similar medical-surgical acute care units. In addition, the survey captured *perceptions* as opposed to *actual* communication patterns. Therefore, the actual accuracy and openness of communication was not measured. To study actual communication patterns would involve an extensive observational study and would be very complex and costly.

6. Conclusions

Communication among the healthcare team is critical for optimal patient care. When communication is not open and accurate, medical errors result. Findings from this study identified nursing characteristics (e.g., experience, unit, shift worked) and the environmental context as essential for open communication. Understanding the environment (e.g., presence or absence of trust, respect, status equity, and time availability) is a foundational step that must occur before implementing any strategies aimed at improving communication. A failure to understand the environment may in part explain why no one strategy has been shown to consistently improve nurse-physician communication [18]. Further research is needed to determine the best strategies for developing trust and respect among the healthcare team. For example, the development of trust requires consistent interaction. Current work environments where staff—both nursing and physicians—rotate, create less opportunity for interaction.

One potential strategy for increasing interactions among the healthcare team would be through consistent team nursing (e.g., nurses on a team work the same shifts/days). This would result in frequent interactions where the antecedents to effective communication (e.g., trust/respect) could develop among the nursing team, and subsequently with other members of the healthcare team.

Another possible strategy for improving communication among the healthcare team includes multidisciplinary education. According to a position paper on interdisciplinary education and practice from the American Association of Colleges of Nursing (AACN), programs and curricula must be developed that incorporate opportunities for collaborative learning and decision making [22]. Educating nurses and physicians together may result in greater role clarity, shared decision making, and more positive attitudes towards collaboration.

Additional strategies for improving communication include encouraging open dialogue, collaborative rounds, and engagement on interdisciplinary committees [23]. This can provide opportunities for discussing problem areas and collaboratively determining strategies to reduce miscommunication. Regardless of strategies implemented, all healthcare professionals have a common commitment to serving the patient and assisting them in reaching their optimal level of functioning. This can result when communication among the healthcare team is open and accurate.

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Research Article

Translational Science and Evidence-Based Healthcare: A Clarification and Reconceptualization of How Knowledge Is Generated and Used in Healthcare

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The importance of basing health policy and health care practices on the best available international evidence ("evidence-based health care") and on translating knowledge or evidence into action ("translation science" or "translational research") is increasingly being emphasized across all health sectors inmost countries. Evidence-based healthcare is a process that identifies policy or clinical questions and addresses these questions by generating knowledge and evidence to effectively and appropriately deliver healthcare in ways that are effective, feasible, and meaningful to specific populations, cultures, and settings. This evidence is then appraised, synthesized, and transferred to service delivery settings and health professionals who then utilize it and evaluate its impact on health outcomes, health systems, and professional practice. Many of the common theories that address this translational process place it apart from the evidence-based practice cycle and most recognise only two translational gaps. This paper seeks to clarify the nature of evidence-based healthcare and translation science and proposes a reconceptualization that both brings together these two dominant ideas in modern healthcare and asserts the existence of a third fundamental gap that is rarely addressed the gap between knowledge need and discovery.

1. Introduction

The challenges related to facilitating the cycle of scientific discovery through to the widespread adoption of a healthcare innovation have become of central concern to individuals and communities who seek or need healthcare; health professionals; policy makers; the funders of health services. Indeed, the interface between identifying knowledge needs for health improvement, pure scientific bench research, clinical trial based research, and, ultimately, the implementation of the results of research into some form of pragmatic outcome is a growing source of ongoing angst in both the research and clinical communities. It is a vital enterprise that, if achieved successfully, has the potential to result in dramatic improvements in global health outcomes. Whilst the translation of evidence into action is the raison d'être of the evidence-based practice movement, so, too, is it the core interest of translation science. Clarifying the nature and components of these two seemingly different (but, in our view, clearly complimentary) fields of endeavour and reconceptualizing this complementarity is important in advancing health policy and practice towards improving the health of people globally.

Nursing in central to the delivery of healthcare and an increasingly major contributor to the evidence-based practice movement broadly and the achievement of evidence-based practice in healthcare settings. Although the origins of evidence-based practice are in medicine, nursing is increasingly playing a role, particularly with respect to aligning practice with evidence at the point of care. Nurse scientists, therefore, are well positioned to take a leadership role in the field of translational science.

2. Clarifying and Reconceptualizing Evidence-Based Healthcare

There are a number of models that attempt to represent the components of evidence-based healthcare to facilitate

understanding, analysis, improvement, and/or the replacement of the process as it is currently conceived, purported and practiced, for example, the Ace Star Model of Knowledge Transformation [1]; the five stage model of evidence-based healthcare [2]; the work of Titler and Everett [3]; the Stetler Model of Research Utilization [4–7]. Dobrow et al. [8] have developed a conceptual framework for evidence-based decision making, and Pearson et al. [9] report on the development of the JBI model of evidence-based healthcare (JBI Model).

2.1. The JBI Model. The JBI Model is developmental and, building on frameworks that have evolved, was constructed out of experience within the evidence-based practice field; the emerging international work of the Joanna Briggs Institute and the international Collaborating Centers of the Joanna Briggs Collaboration; involvement in disseminating, implementing and evaluating evidence-based guidelines in clinical settings; an examination of the scientific and professional literature.

Evidence-based practice can be conceptualized as clinical decision making that considers the best available evidence; the context in which the care is delivered; client preference; and the professional judgment of the health professional. The JBI model of evidence-based healthcare depicts the four major components of the evidence-based healthcare process as:

(i) healthcare evidence generation;

(ii) evidence synthesis;

(iii) evidence/knowledge transfer;

(iv) evidence utilization.

Each of these components is modelled to incorporate their essential elements, and the achievement of improved global health is conceptualized as both the goal or endpoint of any or all of the model components and the raison d'être and driver of evidence-based healthcare (Figure 1).

Evidence-based healthcare is described as a cyclical process that derives questions, concerns, or interests from the identification of global healthcare needs by clinicians or patients/consumers and then proceeds to address these questions by generating knowledge and evidence to effectively and appropriately meet these needs in ways that are effective, feasible, and meaningful to specific populations, cultures, and settings. This evidence is then appraised, synthesized, and transferred to service delivery settings and health professionals who then utilize it and evaluate its impact on health outcomes, health systems, and professional practice.

The term "evidence" is used in the model to mean the substantiation or confirmation that is needed in order to believe that something is true [10]. Health professionals seek evidence to substantiate the worth of a very wide range of activities and interventions and thus the type of evidence needed depends on the nature of the activity and its purpose. The model depicts the process that the Joanna Briggs Institute uses to frame the provision of the best available evidence as well as utilization resources for health professionals to improve global health.

2.2. Evidence-Based Practice. Central to the JBI understanding of evidence-based practice is that health professionals will use research evidence together with the context of care, patient/client values and preferences, and the experience, expertise, and clinical judgment of the health professional. Using all of this information, health professionals are in a position to make evidence informed decisions.

2.3. Global Health. The model is premised on the belief that global health issues are both the driver and reason for evidence-based practice. The US Institute of Medicine (IOM) describes global health as "the goal of improving health for all people in all nations by promoting wellness and eliminating avoidable disease, disability, and death" [11]. For the purpose of this paper, global health issues are determined to be those as identified by health professionals working at the point of care or patients and consumers of health services. These issues are addressed through the generation of research evidence related to effectiveness, appropriateness, feasibility and meaningfulness for specific populations, cultures and settings.

The JBI model assumes that the raison d'être of the research enterprise is to address unmet needs for knowledge; that is, to identify and address concerns that arise out of the experiences of patients/clients, the users of healthcare, healthcare professionals, and families, carers, and communities to generate evidence that will effectively and appropriately meet these identified needs [9].

2.4. Healthcare Evidence Generation. The model asserts that evidence may derive from experience, expertise, inference, deduction, or the results of rigorous inquiry but recognizes that "the results of well-designed research studies grounded in any methodological position are seen to be more credible as evidence than anecdotes or personal opinion" [9]. However, when no research evidence of this level exists, other evidence may represent the "best available evidence" for a specific question. This position is taken to provide the most meaningful and useful information to inform healthcare delivery. The JBI model also recognizes that health professionals consider evidence broader than evidence of effectiveness to inform their everyday practice [9] and that they are interested in evidence of feasibility, appropriateness, meaningfulness and/or effectiveness (FAME). Feasibility is the extent to which an activity is practical and practicable; appropriateness relates to the extent to which an intervention or activity fits with or is apt in a situation; meaningfulness refers to how an intervention or activity is experienced by the patient; effectiveness is the extent to which an intervention, when used appropriately, achieves the intended effect [9].

2.5. Evidence Synthesis. Evidence synthesis is the evaluation or analysis of research evidence and opinion on a specific topic to aid in decision making in healthcare. Although the science of evidence synthesis has developed most rapidly

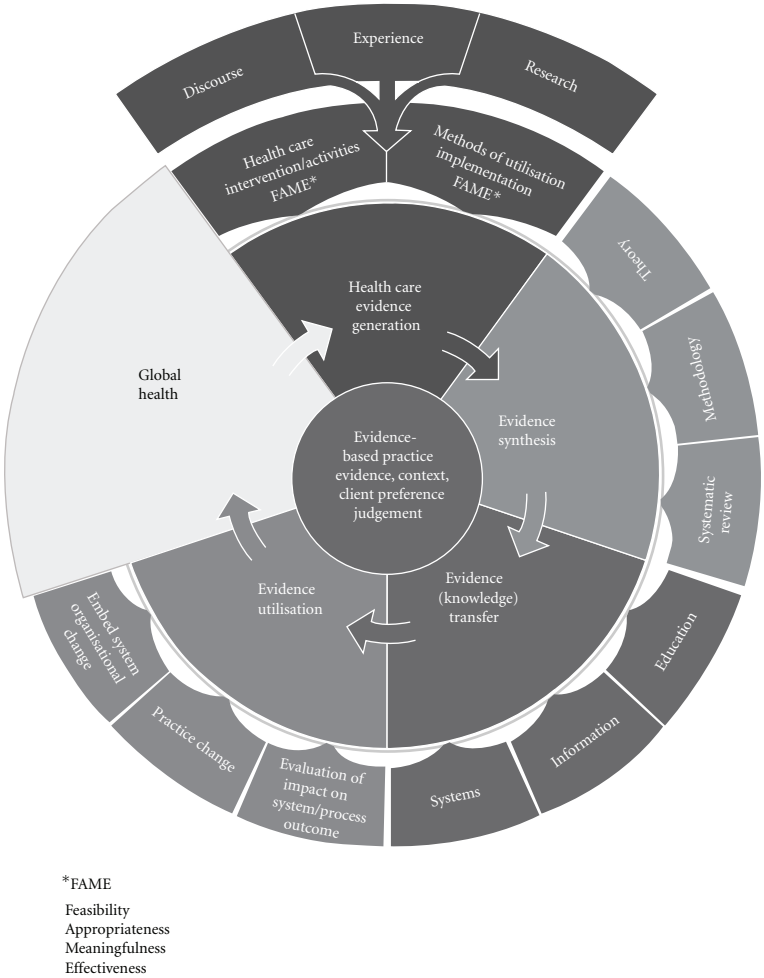

Figure 1: The JBI Model of Evidence-Based Healthcare [9].

in relation to the meta-analysis of numerical data linked to theories of cause and effect, the further development of theoretical understandings and propositions of the nature of evidence, and its role in healthcare delivery and the facilitation of improved global health is identified as an important element of this component of the model. Similarly, the increasing, ongoing interest and theoretical work on methods of synthesizing evidence from diverse sources are depicted as an element of evidence synthesis.

The third element of evidence synthesis is the operationalization of methods of synthesis through the systematic review process. This element in the model is grounded in the view that evidence of feasibility, appropriateness, meaningfulness, effectiveness, and economics are legitimate foci for the systematic review process; and that diverse forms of evidence (from experience, opinion, and research that involves numerical and/or textual data) can be appraised, extracted, and synthesized [12].

There are three elements of synthesis in the model: theories that underpin synthesis, synthesis methodologies and the systematic review of evidence.

2.6. Evidence Transfer. This component of the model relates to the act of transferring evidence (knowledge) to individual health professionals, health facilities, and health systems globally by means of journals, other publications, guidelines, electronic media, education and training, and decision support systems. Evidence transfer is seen to involve more than disseminating or distributing information and should include careful development of strategies that identify target audiences—such as clinicians, managers, policymakers and consumers—and methods to package and transfer information that is understood and used in decision making. The model therefore depicts three major elements of evidence/knowledge transfer—education and training, information delivery, and the transfer of evidence though organizational and team systems. [9].

2.7. Evidence Utilization. This component of the model relates to the implementation of evidence into practice, as is evidenced by practice and/or system change. It identifies three elements: evaluating the impact of the utilization of

Figure 2: Two translation gaps in healthcare knowledge.

evidence on the health system, the process of care and health outcomes; practice change; embedding evidence through system/organizational change.

The JBI Model of evidence-based healthcare adopts a pluralistic approach to the notion of evidence whereby the findings of qualitative research studies are regarded as rigorously generated evidence and other text derived from opinion, experience, and expertise is acknowledged as forms of evidence when the results of research are unavailable. Pearson and Jordan [13] say "While considerable work is being undertaken internationally with regard to translational research, an inclusive approach that accounts for all elements of the research cycle is yet to be developed and implemented in a systematic way in many countries". They go on to link addressing these three gaps with the JBI model of evidence-based healthcare (JBI Model) described by Pearson et al. [9].

3. Clarifying and Reconceptualizing Translation Science

The Agency for Healthcare Research and Quality (AHRQ) in the United States report to congress stated that, "the ultimate goal (of AHRQ) is research translation—that is, making sure that findings from AHRQ research are widely disseminated and ready to be used in everyday healthcare decision making." In 1999, AHRQ published its first Translating Research into Practice (TRIP) initiative. The purpose of the TRIP initiative was to generate new knowledge about approaches that promote the utilization of rigorously derived evidence to improve patient care. The Agency's goal was to enhance the use of research findings, tools, and scientific information that would work in diverse practice settings, among diverse populations, and under diverse payment systems [14]. The need to improve the translation of basic and fundamental research findings into routine clinical practice was also one of the main observations of the "Review of UK Health Research Funding" [15].

Knowledge translation has been seen as the process from basic discovery (basic/laboratory science) to intervention development (clinical trials) [16, 17], known as gap 1, translation 1, or T1; development (proven interventions) to delivery (used in practice) [17, 18], known as gap 2, translation 2, T2, or the know-do gap (Figure 2) [16, 18]. These gaps are two major obstacles in knowledge translation [17].

Mode 1 and Mode 2 knowledge have been used to describe different ways of knowledge generation. Whereas "Mode 1 relates to the traditional paradigm of scientific discovery" [19, page 225]. Mode 2 involves active involvement and collaboration of all stakeholders in terms of methodological development related to how to communicate knowledge and how to articulate the research questions. Mode 2 knowledge is seen as reflexive and transdisciplinary [19].

The notion of translation gaps in the research-into-action cycle is common in all of the work in progress internationally, and Pearson and Jordan [13] suggest that there are essentially three critical gaps associated with the translation of research into action to improve outcomes and services (Figure 3).

3.1. Gap 1—From Knowledge Need to Discovery. The first gap relates to the gap between "knowledge needs" (as identified by patients, the community, clinicians, governments, and organizations) and the work undertaken by scientists and researchers during the "discovery" process. Within this gap there can be an integrated approach to topic selection, where there is active collaboration between those conducting the research and the end users of research (clinicians, patients, community). This gap is a vital component of translational research and is well addressed by very few groups, a notable exception being the National Institute for Health Research in the UK, with its associated Clinical Research Networks and its community engagement program "INVOLVE."

3.2. Gap 2—From Discovery to Clinical Application. The second commonly identified gap relates to the gap between what is referred to here as "discovery research" (theoretical, epidemiological, or "bench" style research) and "clinical research" (experimental trials including but not limited to drug trials). This gap is the most commonly addressed gap on the international stage with significant work being undertaken in many countries; but for most, this is where translational research begins and ends.

3.3. Gap 3—From Clinical Application to Action. The third translation gap, that of translating research into practice, is rarely represented by strong programs in most countries, although some have recently ventured into this realm, notably in cardiology and metabolic/human nutrition centers.

Translating knowledge into action within healthcare is a complex, evolving, and dynamic process. While various models have been described, an accepted standard approach has yet to be widely adopted. Regardless of the model used, it is clear that three main gaps exist:

(1) the gap between the need for knowledge and the discovery of that new knowledge;

(2) the gap between the discovery of new knowledge and the clinical application of that knowledge;

(3) the gap between the clinical application and the development of routine clinical actions or policy.

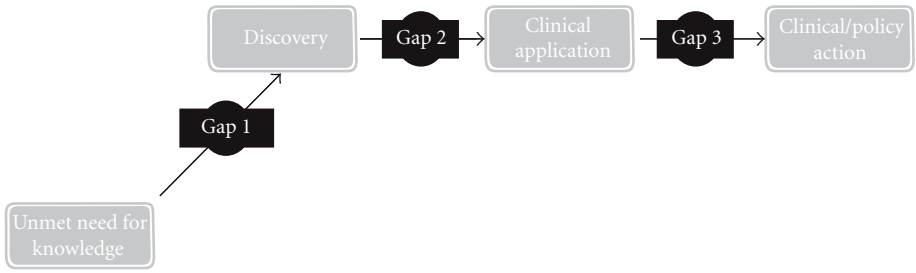

Figure 3: Three translation gaps in healthcare knowledge ([13], 2010).

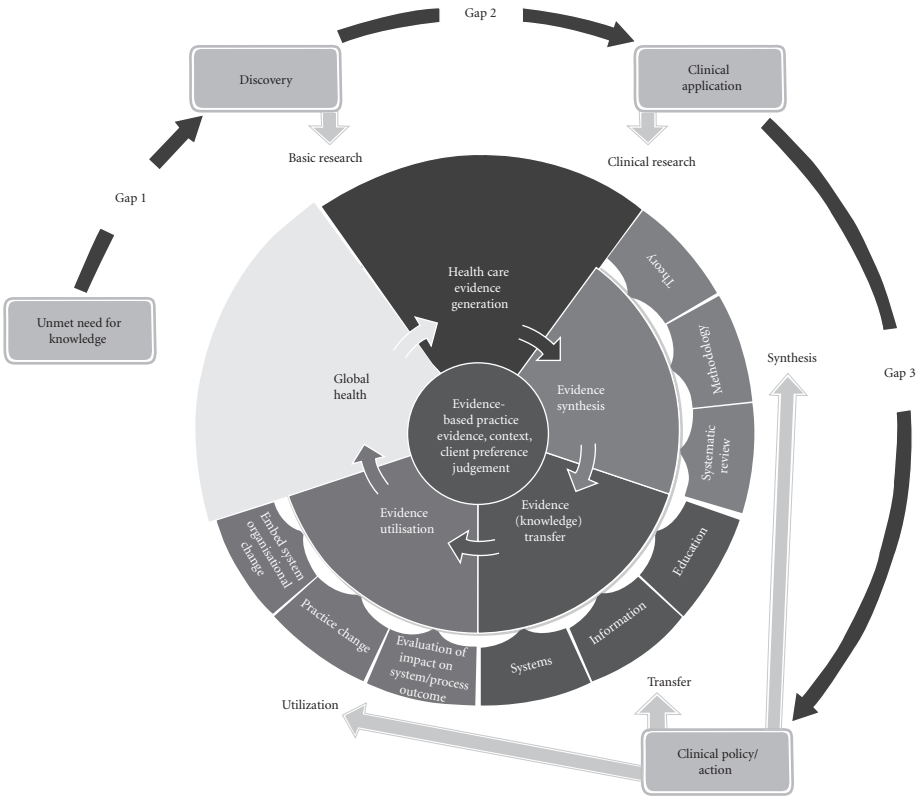

Figure 4: The relationship between the translation science cycle and evidence-based healthcare.

Pearson and Jordan [13], Pearson et al. [9, 20] and Pearson etal. [21], in drawing on the emerging literature, examine the relationship between the translation science cycle and evidence-based healthcare and suggest that the two processes are closely related and are complementary to each other.

4. Clarifying and Reconceptualizing the Relationship between Evidence Based-Healthcare and Translation Science

Pearson et al. [21] assert that the three translation gaps and the elements of the JBI model complement each other in modelling the relationship between the translation science cycle and the pragmatic evidence-based healthcare cycle (Figure 4).

The gap between the need for knowledge and discovery (gap 1) equates with the elements in the JBI Model that focus on the state of global health and the generation of knowledge through the conduct of basic or discovery-oriented research. Applying the findings of discovery research to the "real-world" (gap 2) through the conduct of clinical research (both trials and other health-related research including program evaluation and qualitative inquiry) is also a component of evidence generation. Evidence synthesis, transfer, and utilization in the JBI model represent the processes that most adequately address the gap between clinical application and clinical or policy action (gap 3).

5. Conclusion

Although evidence-based healthcare is gaining acceptance globally, it is complex, sometimes misunderstood, and

frequently maligned. The sources of evidence accessed by practitioners, regardless of its nature—numerical, qualitative, or anecdotal—or its focus—feasibility, appropriateness, meaningfulness, or effectiveness—influences healthcare practice in all disciplines. Research evidence that is rigorously generated, regardless of design, demands due consideration of its quality prior to its utilization in the clinical environment. Evidence that is generated through the conduct of clinical trials; epidemiology; observational studies; qualitative studies; and action-oriented research are essential in addressing the knowledge and evidence needs of individuals and communities and of clinical and policy decision makers [20].

The JBI model of evidence-based healthcare emphasizes the need for the generation, synthesis, transfer, and utilization of evidence derived from diverse research approaches; has been constructed to facilitate reasoning and critique about evidence-based healthcare and its role in improving global health, within a logical conceptual framework.

Translation science (or translational research) is as complex and as frequently misunderstood as evidence- based healthcare. The dominant view of translation science overly emphasises the translation of the results of "basic," "bench," or discovery research into clinical application through the conduct of clinical trials—an enterprise that is now well entrenched in most advanced economies. We contend that translation is much more than the conduct of clinical trials to test discoveries. It begins with translating the questions that arise out of the need for knowledge in the "real world" into discovery research (addressing what we describe as gap 1); translating the findings of discovery research into clinical or policy application through clinical or policy research (addressing what we describe as gap 2); translating the findings of clinical or policy research into action at the clinical or policy level (addressing what we describe as gap 3). Integrating these three translation gaps into a model of evidence based health appears, to us, to clarify and reconceptualize the complexities of improving health outcomes through translating knowledge into action.

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