THE RELATIONSHIP BETWEEN ELECTRONIC NURSING CARE REMINDERS AND MISSED NURSING CARE

by

Ronald J. Piscotty

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Doctoral Committee:

Professor Beatrice Kalisch, Chair
Assistant Professor Jane Brokel, University of Iowa
Assistant Professor AkkeNeel Talsma
Assistant Professor Kai Zheng

DEDICATION

I dedicate this doctoral dissertation to Dr. Diane Norris, PhD, RN. As Associate Dean not only did you give me the me the opportunity to teach at Oakland University in 2007, but you also gave me hope. This was a very troubling time in my life and your kindness, generosity, guidance, support, and helped to ensure my present success as an educator, scholar, and as a person. I will be forever changed for knowing you and forever grateful that you came into my life. You were taken from us all too soon. You will be forever missed and never forgotten.

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ABSTRACT

Purpose: The purpose of this descriptive study was to: (1) determine the relationship between nurses' level of use of reminders and missed nursing care, (2) examine mediators that may exist among variables, and (3) compare nurses with positive/negative reports on the impact of health care information technology on practice and level of use, to determine if they have lower levels of missed nursing care.

Conceptual Framework: A modified Structure, Process, and Outcome Model of Healthcare Quality guided this study. In the modified model it was hypothesized that an electronic health record with nursing care reminders (structure) will directly impact registered nurse usage of nursing care reminders. The model suggests that the registered nurses' perceived impact of healthcare information technology on their practice will mediate the relationship between the levels of registered nurse use of the reminders and missed nursing care.

Subjects: The sample (N = 165) consisted of staff nurses employed at a local hospital in the Midwestern United States during Fall 2012. The majority of the respondents held a Bachelor's Degree as their highest level of education (n = 114, 69.1%), with 67.1% (n = 110) of those participants having a Bachelor's of Science degree in Nursing (BSN). The majority of respondents were female (n = 145, 87.9%) and between the ages of 25 and 34 (n = 61, 37.0%). Over half of the participants in the study (n = 104, 63.0%) worked on a medical surgical unit.

Methods: Hospital and university institutional review board approval was obtained. Surveys were administered online using the Qualtrics survey software. An email was sent to each nurse

inviting him or her to participate. Unit managers were contacted via email to inform them of the study. A reminder was sent to each nurse twice per week during the study period. Flyers encouraging participation were placed by time clocks on each unit. All surveys were due within four weeks from the initiation of the study. Demographic data were analyzed using descriptive statistics and adjusted relationship, mediation, and comparisons were analyzed using hierarchical multiple regression analysis.

Results: There was a significant negative relationship (beta = - .28, $p < .001$) between nursing care reminder usage and missed nursing care. There was a significant negative relationship (beta = - .34, $p < .001$) between the impact of healthcare information technology on practice and missed nursing care. Mediation was also determined to be occurring between nursing care reminders, impact of healthcare information technology on practice, and missed nursing care. Nurses with higher reports of reminder usage had decreased reports of missed nursing care (beta = -.22, $p < .004$). Nurses with higher perceptions of impact of healthcare IT (I-HIT) had decreased reports of missed nursing care (beta = -.27, $p = .001$).

Conclusions: The results of this study are significant and can be used to encourage nurses to use nursing care reminders, helpful for information system designers when designing nursing care reminders, and helpful to healthcare organizations in assessing the impact of technology on nursing practice. It is imperative that missed nursing care be decreased to improve patient and organizational outcomes. Nursing care reminders may be a viable solution to reduce missed nursing care in a technology rich healthcare environment.

Chapter I

Statement of Problem

Introduction

Health care information technology (HIT) is being implemented at an ever-increasing rate in both acute care and ambulatory care settings in the United States. The impetus to implement these systems has come from seminal works, such as the Institute of Medicine's (IOM) *To Err Is Human* and *Crossing the Quality Chasm* (Institute of Medicine [IOM], 1999; 2001). These works recommended and laid the foundation for using information technology to improve patient safety and health care outcomes (IOM, 1999; 2001). The adoption of HIT is imperative for improving the health of the nation, and as such, it is one of the Healthy People 2020 proposed recommendations (U.S. Department of Health and Human Services, 2009). The IOM has also listed the implementation of HIT and clinical decision support systems (CDSSs) as one of its 100 priority areas of research (IOM, 2009).

HIT also received a significant amount (~$36 billion) of funding under the American Recovery and Reinvestment Act (ARRA) of 2009 in order to support the rapid implementation and adoption of HIT in the country (Healthcare Information Management and Systems Society [HIMSS], 2010). The focus on HIT as a national strategy to contain health care costs and improve quality and safety of care is to be commended, but there has been very little research describing how HIT impacts nursing practice (Dykes, Huryley, Cashen, Bakken, & Duffy, 2007). The cost-effectiveness and quality enhancing properties of (HIT) are oft cited as compelling reasons and catalysts for increased implementation, but the evidence base is inconclusive

(Goldzweig, Towfigh, Maglione, & Shekelle, 2009). This is of great importance as the largest group of health care providers in the nation is registered nurses.

The effects of hastily and poorly implemented HIT systems have been highlighted in the media and the literature (Ash, 2007; Han et al., 2005; Koppel et al., 2005). When systems are poorly implemented, the outcome can be "unintended consequences," which can increase error rates or result in errors that had not been seen before the implementation. These errors can severely affect the quality of care and patient safety. Causes of unintended consequences have been linked to a poor understanding of clinician workflow and systems that are ill prepared to support clinician workflow (Aarts, Ash, & Berg, 2007; Harrison, Koppel, & Bar-Lev, 2007).

In contrast, well-designed systems that incorporate CDSS and interdisciplinary communication may actually improve care (Dykes et al., 2007). This is accomplished by enabling nurses to more easily monitor, detect changes in patient conditions earlier, and improve communication within the healthcare team (Dykes et al., 2007). These systems provide alerts, reminders, and/or recommendations that are used to guide nursing practice. These prompts are often designed to deliver evidence-based suggestions to guide practice or influence clinical decision-making.

CDSS: An Overview

Hunt, Haynes, Hanna, and Smith (1998) defined CDSS as, "…any software designed to directly aid in clinical decision making in which characteristics of individual patients are matched to a computerized knowledge base for the purpose of generating patient-specific assessments or recommendations that are then presented to clinicians for consideration" (pp. 1339-1340). Kawamoto, Houlihan, Balas, and Lobach (2005) expanded this definition to include both electronic and non-electronic systems. Thus, a CDSS can include: paper-based systems,

standalone systems such as diagnostic algorithms, application integrated systems such as those embedded in computerized provider order entry (CPOE) systems, systems ?integrated such as those found in electronic health records (EHR), and enterprise integrated systems that share and monitor data across systems and platforms (e.g., between clinical systems and financial systems). The type of CDSS that will be of interest in this study is one that is integrated into an electronic health record (EHR).

There are several functions of CDSSs: (1) alerts (e.g., allergic reaction warnings), (2) reminders (e.g., antibiotic order renewal), (3) clinical guideline recommendations, (4) diagnostic support, (5) surveillance (e.g., tracking H1N1), (6) disease prevention (e.g., yearly mammography), (7) disease management (e.g., monitoring A1C in type II diabetics), and (8) prescription or medication management (e.g., anticoagulant dosage titrations) (Hunt et al., 1998; Kowamoto et al., 2005). The focus of this study will be to examine nursing care reminders.

Missed Nursing Care

Furthermore, little is known regarding the actual process of nursing care and how that contributes to quality and safety. Nursing process is often termed a "black box" as it is yet to be widely studied and understood (Kalisch, McLaughlin, Waller, 2012). Missed nursing care is a measure of nursing process and is considered an error of omission (failing to do the right thing) versus an error of commission (doing the wrong thing) (Agency for Healthcare Research and Quality [AHRQ], 2011; Kalisch, Landstrom, & Williams, 2009). Missed nursing care is defined as any aspect of required patient care that is omitted (either in part or whole) or delayed (Kalisch, Landstrom, & Hinshaw, 2009). Similar concepts to missed nursing care include care rationing and unfinished care (Lawless, Wan, & Zeng, 2010; Schubert et al., 2008; Sochalski, 2004). The AHRQ suggests that errors of omission are much more common than errors of commission and

that they are often unreported (2011). Kalisch has conducted a significant amount of basic research regarding missed nursing care. This foundational work provides a body of knowledge regarding missed nursing care to guide more detailed research.

The logical next steps regarding missed nursing care research are to examine relationships between possible decision support interventions to reduce missed nursing care. In this regard, an application of HIT can be viewed as a potential intervention to decrease missed nursing care. It is hypothesized that nurses that have positive perceptions about the impact of HIT (I-HIT) on their work will report less missed nursing care. Nursing care reminders are of particular interest as they are considered a form of CDSS. Nursing care reminders are items that the nurse is expected to complete before the end of their shift. The care reminders are delivered to nurses in a variety methods such as "dashboard" alerts, worklists or queues, order lists, pop-up reminders, and/or reminders integrated into other modules of the EHR such as an intervention list in the care planning documentation, among others.

Significance to Nursing

This study is a first step in determining if there is a relationship between electronic nursing care reminders and missed nursing care. This is of great importance as it is hypothesized that an electronic system that has nursing reminders should result in decreased missed nursing care. In several studies, the primary reason for missed nursing care was related to nurse staffing adequacy, specifically labor resources (Gravlin & Bitner, 2010; Kalisch, 2009; Kalisch et al., 2009; Lawless et al., 2010). When a deficit in the adequacy of nursing labor resources is present, this may lead to missed nursing care. When nurses are faced with a shortage of resources and increased patient loads potential interruptions and distractions may occur.

One of the major negative effects of decreased labor resources on nursing practice centers on its potential to cause distractions and interruptions (Bittner, Gravlin, Hansten, & Kalisch, 2011). Pape (2002) described a distraction as anything that diverts one's attention from achieving a desired goal. The primary impact of distraction is the filling of working memory due to information overload or competing attention (Pape et al., 2005). Pape et al. (2005) stated that working memory is where temporary information is stored, and since distractions can impact working memory, they may result in a loss of concentration, and thus, lead to missing care. In a recent case analysis, Brixey, Robinson, Johnson, Johnson, Turely, & Zhang (2007) defined an interruption as any break in human performance by an internal or external stimulus.

Brixey et al. (2007) defined five attributes of an interruption as: (1) a human experience, (2) an intrusion of an unplanned secondary task, (3) discontinuity, (4) externally or internally initiated, and (5) situated within a context. Brixey et al. (2007) noted that interruptions in work settings such as aviation, nuclear power plants, and healthcare could result in catastrophic failures including loss of life. Interruptions and distractions can have an impact on nurses working memory. Unless the nurse is reminded in some way, a nursing intervention may be missed. Nursing care reminders are an intervention to remind nurses of missed nursing care during their shift (Kalisch & Aebersold, 2010).

The second most common reason for missed care is material resources (Gravlin & Bitner, 2010; Kalisch, 2009; Kalisch et al., 2009). Specifically, missing equipment/supplies, medications, and/or equipment not functioning (Kalisch et al., 2009). Electronic reminders may be useful in addressing a lack of material resources as a nurse may move on to another task while waiting for the missing equipment, supplies, or medications to arrive. The nurse may then experience an interruption and forget to administer the required intervention. The reminder may

serve as a cue that the activity or intervention needs to be completed. This may thus result in a decreased amount of missed nursing care.

The third most common reason for missed nursing care is communication and teamwork (Gravlin & Bitner, 2010; Kalisch, 2009; Kalisch et al., 2009). This includes such things a communication breakdowns, poor care handoffs, and others not providing required care as delegated, among others. Electronic reminders may improve communication and teamwork and as such decrease the amount of missed nursing care. This may occur when communications breakdown occur. The reminder may serve to notify the nurse that a particular activity or intervention has not been delivered. The nurse can then follow-up with the appropriate individual to ensure activity or intervention completion.

Additionally, our understanding of the impact of missed nursing care on patient care outcomes is not well understood. In one study, missed nursing care was found to be a mediating factor in increasing patient falls (Kalisch, Tschannen, & Lee, 2012). In another study, care rationing was a significant predictor of six patient outcomes: (1) patient satisfaction, (2) medication errors, (3) patient falls, (4) nosocomial infections, (5) critical incidents, and (6) pressure ulcers (Schubert et al., 2008). If missed nursing care, a form of care omissions is indeed having a negative impact on patient outcomes, interventions need to be developed to reduce the amount of missed nursing care.

Aim

The aim of this study is to understand the impact of HIT (nursing care reminders) on nursing practice process (missed nursing care).

Purpose

The purpose of this study is to: (1) determine the relationship between nurses' level of use of reminders and missed nursing care, (2) examine mediators that may exist among variables, and (3) compare nurses with positive/negative reports of the impact of HIT on practice and level of use, to determine if they have lower levels of missed nursing care.

Conceptual Framework

Conceptual Framework Analysis

The overall research trajectory of the author of this study is to understand the impact of HIT on nursing practice. The plan is to eventually examine this from a structure to outcome perspective. It is the author's overall hypothesis that although structure or HIT can have a direct impact on process and outcomes, there are mediating and moderating variables that influence or explain a greater part of the variance. Additionally, HIT systems or even applications may have little direct improvement on process and outcomes. An understanding of the underlying relationships between HIT applications and the impact on process is desperately needed. Once the relationships are established, the examination of the associations between HIT and health and organizational outcomes can occur. The author's particular interest is in regard to nursing care reminders embedded within the EHR and their potential to decrease the amount of missed nursing care.

Theoretical foundations for both nursing health services research and nursing informatics research are not well established (Effken, 2003; Mitchell, Ferketich, & Jennings, 1998). Many theories that are used are borrowed from other disciplines such as business management, computer science, information science, and public health. There is currently no widely accepted unifying theory of nursing health services research or nursing informatics research (Effken, 2003; Mitchell, Ferketich, & Jennings, 1998). There have been attempts in both of these areas to

develop such a unifying theory (Effken, 2003; Mitchell, Ferketich, & Jennings, 1998). These attempts have been met with mixed success.

Four conceptual frameworks were examined for this study. The four frameworks examined are:

1. Structure, Process, and Outcome (SPO) Model of Healthcare Quality (Donabedian, 1966; 1969; 1988).
2. Quality Health Outcomes Model (QHOM) (Mitchell et al., 1998).
3. The Informatics Research Organizing (IRO) Model (Effken, 2003).
4. The Technology Acceptance Model (TAM) (Davis, 1989; Davis, Bagozzi, & Warshaw; 1989).

Each of these frameworks will be examined for major concepts, commonalities and differences among the models, and critiqued in subsequent sections.

Structure, Process, and Outcome Model of Healthcare Quality

Donabedian proposed the Structure, Process, and Outcome Model of Healthcare Quality in 1966. The model posits that health care structure, process, and outcomes and associated contextual factors are the underpinnings of healthcare quality. Donabedian (1969) described structure as organizational components or factors such as actual workspace, organizational culture, resource allotment, and clinician characteristics among others. Process is described as the act of care. This would include making clinical decisions and then implementing interventions based on the plan of care. Outcomes were described as the end result of care (Donabedian, 1969). Donabedian (1988) recommended that health research studies should include variables from all three areas (structure, process, and outcome) because there are many factors that influence the quality of care and a weakness in one may be supplemented by strength

in another. Mitchell et al. (1998) state that the SPO is traditionally viewed as a linear model with no feedback loops. Although, some may view the SPO in this manner, it can be inferred that Donabedian did not intend that the model was linear in nature, nor that is was not dynamic in that it did not include feedback loops. Donabedian's statement above that all three components of the SPO be examined in any research study supports this inference.

Quality Health Outcomes Model (QHOM)

The Quality Health Outcomes Model (QHOM) was derived from Donabedian's SPO model. The model contains four main concepts: (1) system, (2) client, (3) interventions, and (4) outcomes (Mitchell et al., 1998). In the QHOM system is defined in a similar nature as structure in the SPO model in that Mitchell et al. (1989) includes individual, organizational, and group characteristics of the system. The client concept is defined as individual, family, or community characteristics. Interventions are clinical processes that are either derived directly or indirectly (Mitchell et al., 1989). Outcomes are defined as the end results of both treatment interventions and/or technology assessment (Mitchell et al., 1998). There are bidirectional relationships between the system and client concepts, and with the system and client concepts with both the interventions and outcomes concepts (Mitchell et al., 1998). There are no direct relationships between interventions and outcomes (Mitchell et al., 1998).

The Informatics Research Organizing (IRO) Model

The Informatics Research Organizing (IRO) model was derived from the SPO model, the QHOM, and the Systems Development Life-Cycle (SDLC) (Effken, 2003). The model in addition to the four concepts of the QHOM also includes six concepts from the SDLC. The SDLC is a process model that includes the concepts of: (1) analyze, (2) design, (3) implement, (4) maintain, (5) plan, and (6) evaluate (Effken, 2003). Effken (2003) labels the concept of

system from the QHOM as context. Effken (2003) describes context as cultural, economic, social, and physical factors. The concept of client is described as the relevant data or information of the client and the clients' or disciplines' behaviors and characteristics (Effken, 2003). Interventions are described as the content, structure, and flow of information and the characteristics of technology (Effken, 2003). Effken (2003) described outcomes as information, knowledge, decisions, or actions to improve cost, quality, safety, and satisfaction. There are bidirectional relationships between context and outcomes, interventions and outcomes, context and client, and client and interventions (Effken, 2003). There are unidirectional relationships going from the SDLC to the other four concepts.

The Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) was also explored as a possible conceptual framework to guide the study. The TAM was ruled out early in the process of theory evaluation due to its limited nature of focus. The focus of the TAM is on perceived usefulness of technology and actual usage of technology (Davis, 1989; Davis et al., 1989). The purpose of this study is beyond the scope of the TAM. Although the TAM extensively examines technology usage, it is deficient in that it does not look at process or outcomes. Therefore, the TAM is not suitable for this study.

Commonalities and Differences

The three conceptual frameworks reviewed for this study have several commonalities. First and foremost, both the QHOM and the IRO model are extensions of the SPO model. Secondly, the IRO is a further extension of the QHOM. Thirdly, they all contain the concepts of structure, process, outcome, and context in one form or another. Lastly, they all contain or it is

implicit that they contain the four components of the nursing metaparadigm. The concept of outcomes is labeled and described similarly in all of the models.

The main differences among the models can be split into two categories: (1) the naming of the concepts and (2) the relationships among the concepts. Donabediain posited that there were direct relationships between structure, process, and outcome with feedback loops from each to the other. Context is contained in the structure concept of the SPO model, whereas the QHOM splits and labels these concepts as system and client and the IRO model splits and labels these as client and context. Process is the name of the concept in the SPO model and it is labeled interventions in the QHOM and IRO model.

The relationships also differ among the models. In the SPO there are direct relationships between structure, process, and outcome and feedback loops between each of the concepts. In the QHOM there is not a direct relationship between intervention and outcomes, but in the IRO there is a bidirectional relationship between the two concepts. Another key difference between the SPO and QHOM and the IRO is that the IRO includes the SDLC and unidirectional relationships to each of the four concepts of context, outcomes, interventions, and client.

Evaluation/Critique

Donabedian's SPO model is the most parsimonious of the three models. The SPO model can almost be viewed as a metaparadigm of healthcare quality. The SPO model serves as a grounding framework for nursing informatics and nursing health services research. The strength of Donabedian's model is its adaptability and generalization to many aspects of nursing informatics research and nursing health services research. The SPO can and has been modified based on individual study needs.

The QHOM although more parsimonious than the IRO model has no direct relationship between process and outcome. The authors state that nursing interventions do not directly impact or arenot? casual factors in regard to outcomes (Mitchell et al., 1998). The author's state that client and system variables mediate/moderate all relationships (Mitchell et al., 1998). One could argue that there is a direct relationship between some but not all nursing interventions and outcomes. It is an unfounded generalization for the authors to state that there are "never" any direct causal relationships between process and outcome. A further critique is that process is split into silos in this model and it is very difficult to place process variables in the model

The IRO model, the least parsimonious of the three models examined, presents the same challenges as the QHOM as it is derived from this model. Furthermore, it is not entirely clear how the SDLC fits into the overall model. A critique is that the relationships between the SDLC variables and the QHOM variables are not well defined by the author (Effken, 2003). It is not logical that the SDLC has only unidirectional relationships with the other four components of the QHOM. It is logical to expect that upon evaluation of outcomes or context, etc. that changes may incur in the SDLC. Additionally, the client variable is not well defined, it contains both client and discipline characteristics (Effken, 2003). Effken (2003) also views interventions as technology characteristics; one could argue that this is not an intervention. It appears as if the SDLC was placed in the QHOM in an effort to turn it into an informatics framework without much thought on how the two models relate or fit together. The author tries to justify this by saying that the concepts of the model were left intentionally abstract for the researcher to interpret in their particular study (Effken, 2003).

Model Chosen for this Study/Rationale

The conceptual framework chosen for this study is the Structure, Process, and Outcome Model of Healthcare Quality. This model was chosen as it provides grounding for the purpose of this study due to the general framework from which it is composed and ultimately is more parsimonious than the other models reviewed. The applicability of this framework to both nursing health services research and nursing informatics research is widely accepted. Kalisch & Lee (2010) used a modified version of the model in their research of missed nursing care.

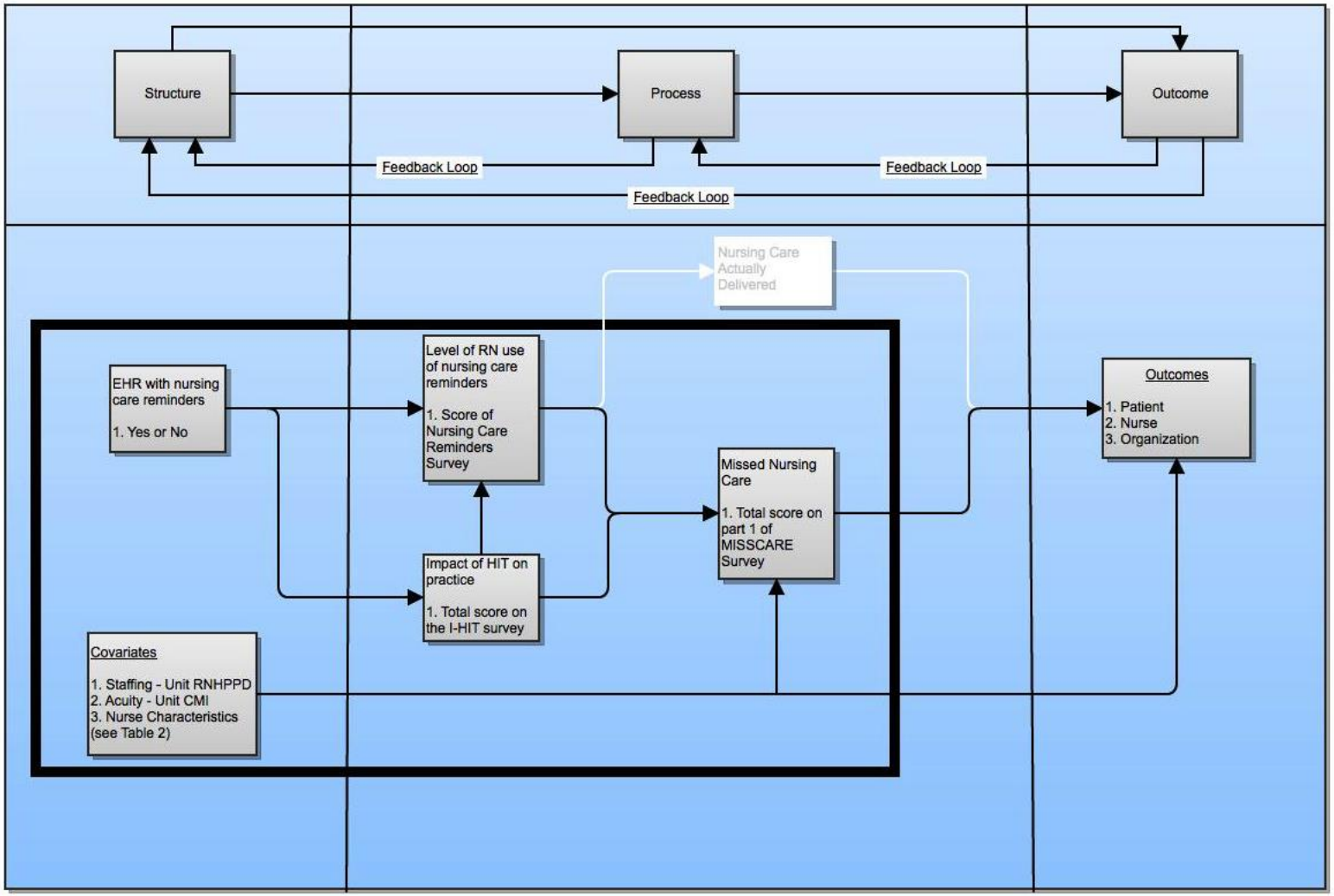
Theory derivation was utilized in the present study by using the model as a grounding framework and using the extant literature to modify the model to meet the purpose of this study. Walker and Avant (2005) consider this an appropriate method of theory derivation. This model can be used to understand the relationships that CDSS (structure) has on clinical decision-making and action (process) and healthcare system outcomes (outcome). In this study, the model is used to understand the relationships that nursing care reminders (structure) have on missed nursing care (process).

Model Overview

The model of the phenomena of interest includes four major concepts and several covariates that are predicted to have influence on missed nursing care (See Figure 1). The highlighted portions of the model will be of interest in this study. The major concepts of the model are electronic nursing care reminders, missed nursing care, level of use of reminders, and impact of HIT on practice (See Table 1 for conceptual definitions and empirical indicators). Conceptual definitions and empirical indicators of covariates are listed and defined in Table 2.

In the modified structure, process, and outcome model (See Figure 1 for a modified version of the model) used in this study, it is hypothesized that an EHR with nursing care reminders (structure) will directly impact registered nurse usage of nursing care reminders. The

model suggests that the RNs perceived impact of healthcare information technology (I-HIT) on their practice will mediate the relationship between the level of RN use of the reminders and missed nursing care. Also, the model suggests that I-HIT may mediate the relationship between the use of nursing care reminders and missed nursing care. In addition there are structural covariates that may also impact missed nursing care such as staffing adequacy, patient acuity, and/or nurse characteristics.



Note: EHR = electronic health record; RNHPPD = registered nurse hours per patient day; CMI = case mix index; RN = registered nurse; I-HIT = impact of healthcare information technology.

Figure 1. Modified Structure Process Outcome Model

*Table 1***.** Conceptual definitions and empirical indicators dependent and independent variables

Dependent Variables	Conceptual Definition	Empirical Indicators
Missed nursing care	Kalisch, Landstrom, and Hinshaw (2009) defined missed nursing care in a concept analysis. Missed nursing care is defined as any aspect of required patient care that is omitted (either in part or whole) or delayed.	Missed nursing care is defined operationally as: The total score on the MISSCARE survey (Kalisch & Williams, 2009).
Independent Variables	**Conceptual Definition**	**Empirical Indicators**
Level of use of EHR nursing care reminders	The registered nurses self-rated level of use of nursing care reminders in their facilities EHR.	Level of use of nursing care reminders is operationally defined as the nurses total score on the nursing care reminders survey.
Impact of healthcare information technology on nursing practice	Nurses' perceptions of the influence that HIT has on interdisciplinary communication, workflow patterns, and satisfaction with HIT applications available in hospitals.	Total score on the I-HIT scale (Dykes et al., 2007).

*Table 2***.** Conceptual definitions and empirical indicators of control variables

Nurse Characteristics	Conceptual Definition	Empirical Indicator
RN Age	Length of time since birth date	Number of years
RN Gender	RN gender	Male or female
Years and months of experience in current role	Years and months of practice in current role	Number of years and months
Years and months of experience as a registered nurse	Years and months as a registered nurse	Number of years and months
Years and months of experience with current electronic health record (EHR)	Years and months of use of current electronic health record (EHR)	Number of years and months
Highest level of education	Highest level of education in which a degree was conferred on academic transcript	Diploma; Associates; Bachelors; Masters; PhD; DNP
Employment status	Current employment status	Full-time or Part-time
Staffing Adequacy	**Conceptual Definition**	**Empirical Indicator**
Unit RN hours per patient day (RNHPPD)	The number of productive hours worked by RNs with direct patient care responsibilities divided by patient days (American Nurses Association [ANA], 2009, p. 8)	Monthly RN nhppd = total RN nh / total patient days Quarterly RN nhppd = sum of monthly RN nhppd / # of reporting months (ANA, 2009, p. 8)
Acuity	**Conceptual Definition**	**Empirical Indicator**
Unit case mix index (CMI)	Relative severity of illness of patient population	Sum of CMI scores of discharged patient)/(total number of discharged patients) (monthly)

Constructs

Based on the theoretical underpinnings and the review of the literature, the main constructs of the phenomenon of interest are electronic nursing care reminders, missed nursing care, level of use of reminders, and impact of HIT on practice. Electronic nursing care reminders are defined as an electronic list, prompt, or cue of tasks or procedures that need to be completed by either the nurse or nursing assistant (NA) during their shift. An EHR is defined as an electronic database and accompanying graphical user interface which enables clinicians to document and retrieve patient care information that aids the clinician in clinical reasoning to make informed clinical decisions. This would include but is not limited to computerized physician order entry (CPOE), order and result processing and communication, patient scheduling, clinical reminders, task or work lists, and clinical documentation. The EHR must specifically contain an electronic list, prompt, or cue of tasks or procedures that need to be completed by either the nurse or nursing attendant during their shift.

Kalisch, Landstrom, and Hinshaw (2009) defined missed nursing care in a concept analysis. Missed nursing care is defined as any aspect of required patient care that is omitted (either in part or whole) or delayed. Level of use of reminders is defined as the registered nurses self-rated level of use of nursing care reminders in their facilities EHR. Impact of healthcare information technology (I-HIT) on practice is defined as the nurses' perceptions of the influence that HIT has on interdisciplinary communication, workflow patterns, and satisfaction with HIT applications available in hospitals.

Relationships Between Constructs

CDSSs influence the process of care. If a clinician uses a CDSS reminder, this may decrease the amount of missed nursing care. There are a number of factors that are hypothesized

to influence the use of CDSS by clinicians. These factors either present, absent, or in varying combinations may contribute or influence the level of use of CDSS by clinicians. The level of use may influence working memory. Use may occur on a continuum with the clinician not using the CDSS recommendation or on the other end of the continuum of using the CDSS recommendation fully. There may be other levels of usage in between where the clinician may use the recommendation to some partial degree or for a purpose or use not intended by the designer of the system. Clinical judgment includes decision-making, action, or inaction regarding the best plan of care for patient and may result in actual care provided or missed nursing care.

Credibility of the Model for Nursing Science

Depending on the perspective chosen, the phenomenon of interest may be considered to build nursing science and the discipline. If you were viewing from a purist nursing science view, then the phenomenon would not be considered to build nursing science and the discipline because it does not utilize a pure nursing theory as the underlying framework to guide conceptualization and testing (Barrett, 2002; Rawnsley, 2003). If looking at it from a more liberal framework then the phenomenon would contribute to nursing science as the model, although not conceptualized from a nursing theory, is concerned with the impact of information systems on nursing practice, and as such, the phenomenon of interest builds both nursing science and the discipline (Barrett, 2002; Rawnsley, 2003). Furthermore, the model includes and addresses the four metatparadigm concepts of nursing: Person, environment, health, and nursing. Person is addressed as the effect of the nurses' decision to use CDSS recommendations that may influence the patients' healthcare outcomes. The model also looks at the environment in the form of structural aspects that impact the nurses' rate of adoption of guideline recommendations. Health is of importance as guideline adoption may influence the health status of the patient.

Finally, the nurse is the focus of this model of how structural factors may influence their adoption of recommendations and the impact this has on their clinical judgment.

Research Questions

Relationships

1. Controlling for CMI, RNHPPD, and nurse characteristics examine the following relationships:
    a. Is there a relationship between nurses' level of use of reminders and missed nursing care?
    b. Is there a relationship between I-HIT scores and missed nursing care?

Mediating Relationships

2. Does I-HIT mediate the relationship between nursing care reminders and missed nursing care?

Comparisons

3. Controlling for CMI, RNHPPD, and nurse characteristics compare the following:
    a. Do nurses who report higher levels of use of nursing care reminders have reports of decreased or less missed nursing care?
    b. Do nurses who have more positive perceptions of I-HIT on their practice have reports of decreased or less missed nursing care?

Chapter II

Literature Review

Literature Review Synthesis: CDSS Usage by Nurses and Missed Nursing Care

A review of the literature was conducted on the two major phenomena of interest in this study: (1) nursing use of CDSS and (2) missed nursing care. The literature review is presented in a synthesized format. Specific study details can be located in literature matrices created for this review (See Appendices A & B). A synthesis of the literature of CDSS usage by nurses is presented first and followed by a synthesis of the literature of missed nursing care.

Literature Review Synthesis of CDSS Usage by Nurses

A review of the literature was conducted to determine the breadth of understanding surrounding the phenomena of nursing use of CDSS. Pub Med and the Social Science Index were two databases that were searched. The keywords used included: Nursing, CDSS, decision support, clinical decision support, reminders, use, adoption, and adherence. Key words were combined to narrow down the results. Two major informatics journals *(Journal of the American Medical Informatics Association* and *Computers and Informatics in Nursing*) were also hand searched for relevant articles. Articles were included in the review if they had a focus on nursing usage, adoption, and/or adherence to CDSS. The time period searched was open ended, as the concept of nurse use of CDSS is a relatively new concept.

The literature retrieved was synthesized into common themes. The common themes that emerged from the review of literature on CDSS usage by nurses include: (1) CDSS effectiveness, (2) Nurse factors affecting usage, (3) Patient factors affecting usage, (4) Technology and design

factors affecting usage, and (4) Organizational factors affecting usage. The themes are listed below and are discussed with a summary synthesis of the gaps in knowledge regarding CDSS use by nurses.

CDSS effectiveness

The literature surrounding CDSS suggests that CDSS are effective to some extent. The majority of effectiveness studies that have been conducted examined physician performance. The effectiveness of CDSS in improving nursing clinical practice is not well known. Hunt et al. (1998) reported in a systematic review of controlled trials that CDSS effects on performance were assessed in 65 studies and of those 65, 43 found benefits (66%). Garg, et al. (2005) reported in a systematic review of 100 studies that CDSS improved practitioner performance in 62 or 64% of studies. Improved performance was associated with a CDSS that automatically prompted users vs. those that the user has to initiate (success in 73% vs. 47% of the studies) and in studies in which authors developed the CDSS software (success in 74% vs. 28% of the studies) (Garg et al., 2005). Kawamoto et al. (2005) reported in a systematic review of 70 studies that decision support systems significantly improved clinical practice in 68% of those trials. The study also reviewed features of CDSS that improved clinical practice. They reported four system features identified as contributing to clinical improvements: (1) automatic provision of decision support as part of clinician workflow, (2) provision of recommendations rather the just assessments, (3) provision of decision support at the time and location of decision making, and (4) computer based decision support. Of the 32 systems possessing all four features, 30 (94%) improved clinical practice (Kawamoto et al., 2005).

Randell, Mitchell, Dowding, Cullum, and Thompson (2007) conducted a systematic review of the effectiveness of CDSS in improving nursing care. Of the studies reviewed, eight

were included in the final review. None of the studies found an impact of CDSS on patient outcomes. CDSS was found to be effective in two studies that looked at triage. The CDSS improved performance as it reduced physician workload when nurses used the CDSS. One study reviewed suggests that CDSS is detrimental to patient outcomes, while another suggested it is beneficial for some outcomes (Randell et al., 2007). The authors concluded that benefits of CDSS are inconclusive and need further investigation (Randell et al., 2007). Titler (2008) reported in a integrative review on evidence based practice implementation that CDSSs have been found to be effective in aligning practice with the evidence base. Titler (2008) also commented that there is still a need to understand the best way of delivering evidence through electronic health records.

Nurse factors affecting usage

There is limited attention placed on clinician factors that may influence the adoption of CDSS recommendations. Alquraini, Alhashem, Shah, and Chowdhury (2007) conducted a survey study to determine nurse's attitudes towards computerization in Kuwait. The authors found that there are differences in attitudes regarding clinical information systems in relation to nationality, level of education, pervious experiences in computer use, and computer skills. The study also reported that gender (females), nationality (non-Kuwaiti), higher education levels, and longer duration of computer use were statistically significant predictors of positive attitudes towards computerized health information systems (Alquraini, Alhashem, Shah, & Chowdhury, 2007). Dowding et al. (2009b) conducted a multi-site case analysis to determine nurses' use of CDSS. Dowding et al. (2009b) reported that nurses' experience with decision and technology affected how they used a decision support system and whether or not they over-rode recommendations made by the system.

O'Cathain, Munro, Armstrong, O'Donnell, and Heaney (2007) conducted a survey study examining nurses' attitudes toward risk and the effect this had on clinical decision-making. O'Cathain et al. (2007) reported that nurses' attitudes toward risk varied greatly. Using multilevel modeling and after case-mix adjustment, there was some evidence that nurses' attitudes towards risk affected decisions but this was inconsistent and unconvincing. Much of the decision-making remained unexplained by the models. Weir et al. (2007) conducted an observational and survey studying examining clinicians' information management strategies in regard to computerized order entry. The authors noted that in order to promote CDSS adoption, the CDSS must be designed to allow for fast and accurate decisions.

Titler (2008) reported that characteristics of users such as education, practice specialty, and views of innovativeness might influence adoption of EBP although findings are inconclusive. She also stated that EBP must be aligned with workflow to foster adoption. It was also noted that nurses' disposition towards critical thinking is positively correlated with research use. In an integrative review of patient care technology and safety, Powell-Cope, Nelson, and Patterson (2008) reported that characteristics of nurses that moderate and mediate the use of technology in practice include: age, experience, mindset about technology/attitudes, self-efficacy, attention, fatigue, sensory inputs, perception, goals, intention to use, and knowledge.

Courtney, Alexander, and Demiris (2008) examined existing literature from the Novice to Expert Nursing Framework to aid in HIT implementation for nurses. They reported that the CDSS must fit within the workflow of the clinician if they are to adopt the recommendations. They must feel that CDSS addresses a particular and important concern for clinical practice (Courtney, et al., 2008). Randell and Dowding (2010) conducted a multiple site case study that examined organizational influences on nurses' use of CDSSs. A key theme that emerged from

the analysis indicated that in order for a system to be successful clinician engagement is necessary. Choi, Choi, Bae, and Lee (2011) conducted a qualitative study using focus groups to examine type and content of CDSSs that improved patient safety. The nurses consistently stated that CDSSs could contribute to improving nursing outcomes by standardizing nursing care. The nurses wanted a system to remind them of scheduled care, assesses deleterious changes in patient condition, and acuity level.

Dowding et al. (2009a) conducted a secondary analysis of survey and observational data to examine the impact of nurse experience on CDSS usage. Dowding, et al. (2009a) reported that nurses tended to use the CDSS recommendations when they first started working in a clinic and had little experience in their role. As the nurses gained more experience, they were less likely to follow the guidance contained within the CDSS and use their own professional judgment and override recommendations if they felt they were not appropriate. Experienced nurses still valued CDSS and utilized it with unfamiliar cases or as a memory aid. They used the CDSS as a "safety-net". Cho, Staggers, and Park (2010) conducted a repeated measures study to examine nurses' responses to different amounts of information in CDSSs. The authors reported that user preferences for display of information in CDSSs differed significantly between novice and expert nurses. The novice nurses wanted to see all possible problems for patients, whereas expert nurses only wanted to see the top five problems.

Ernesater, Holstram, and Engstram (2009) conducted a qualitative study using interviews to determine telehealth nurses use of CDSSs and how they influence their work. Enrnesater et al. (2009) reported that nurses experienced their work with decision support as supporting, inhibiting at time, and quality improving. The main theme identified is that the system strengthened their practice but at the same time controlled and inhibited their professional

judgment. Specifically that the system was incomplete and sometimes in conflict with their own opinion, which felt controlling. They preferred working with the system but described that the CDSS could not replace their knowledge and competence and that it should be considered complementary to ensure the quality of tele-nursing.

Weber, Courtney, and Benham-Hutchins (2009) conducted a qualitative study using interviews to determine how CDSSs facilitate communication between physicians, nurses, patients, and family members in intensive care units. Weber et al. (2009) reported that nurses and physicians are motivated to use a CDSS when it allows them to forecast potential outcomes of decisions prior to actually making those decisions. When the system decisions are congruent with that of the clinician prediction, the clinicians are more likely to incorporate the system recommendation into practice. Nurses were also more apt to use the system once they found out they could use the data to influence physician decisions. The system was used to support or back-up the clinical decisions that were made. Campion, Waitman, Lorenzi, May, and Gadd (2011) conducted an observational study to determine barriers and facilitators of a computer-based intensive insulin therapy CDSS. They noted that a facilitator to successful use of CDSS by nurses is that it has to be aligned with the nurses' clinical judgment.

Randell, Mitchell, Thompson, McCaughan, and Dowding (2009) conducted a secondary analysis of interviews and observations to examine the use of CDSS to inform nurse decision-making. Randell et al. (2009) reported that many of the nurses felt there was a need for decision tools to ensure consistency in practice. Nurses stated that they always followed the guidelines and they had memorized them. They stated they were working from the guidelines even when not looking at them. Working with the guidelines occurred infrequently. Guidelines would sometimes be checked after the event to ensure that they had taken the correct action. The nurses

stated that they had helped develop the guidelines and they wanted national guidelines to be user-friendlier and to be able to adapt them to meet their needs.

Patient factors affecting usage

The literature review yielded very little information on how patient characteristics influence CDSS guideline adoption by registered nurses. In two studies, it was reported that when nurses encountered patients with more complex cases, this often necessitated the need to use the CDSS guidelines (Dowding et al., 2009a; Dowding et al., 2009b). It was also noted that when a nurse was not familiar with a patient they often utilized the CDSS recommendations (Dowding et al., 2009a; Dowding et al., 2009b). Randell, Mitchell, Thompson, McCaughan, and Dowding (2009) reported that nurses when encountering unfamiliar patient cases often utilized CDSS guidelines.

Technology and design factors affecting usage

Several studies were identified that addressed the system design and the impact that this may have on nurse use of CDSS recommendations. Saleem et al. (2005) conducted an observational study to identify barriers and facilitators to CDSS usage by nurses. Saleem et al. (2005) reported that system design barriers to using the system optimally included: lack of coordination between nurses and providers, using the reminders while not with the patient which impaired data acquisition and/or implementation of recommended actions, workload, lack of reminder flexibility, and poor interface usability. Facilitators to using the system optimally included: limiting number of reminders at a site, strategic location of the computer workstations, interaction of reminders into workflow, and ability to document system problems and receive prompt administrator feedback. Marshall, West, and Aitken (2011) conducted an instrumental case design study to examine critical care nurse's preferred information sources for decision

making. The nurses in the study preferred information sources that are from other nurses and colleagues. The nurses reported that electronic resources were not utilized because they were perceived as less accessible and took too much time to access information.

In another study conducted by Saleem et al. (2007) designed to address barriers regarding CDSS adoption, it was reported that modest design modifications to existing clinical reminder software positively impacted variables that likely increase the willingness for first-time nursing users to adopt and consistently use clinical reminders. Powell-Cope, Nelson, and Patterson (2008) reported that technology characteristics that influence technology use by nurses include: reliability, validity, ergonomic design, output display, input mechanism, interface, and compatibility with other technologies. Campion et al. noted that a lack of reminders and inaccurate user interface design are barriers to nurses' use of CDSSs. Cho et al. (2010) reported in a study examining the amounts of CDSS information delivered to nurses, that a facilitator to use was a CDSS that is well-organized and facilitated patient problem identification. A barrier identified was that the nurses felt that the data input into the CDSS was tedious and difficult and the display for data input was too complicated. The nurses also felt that automatic suggestions and data driven approaches to assessments were desirable features of the system.

O'Neill, Dluhy, Hansen, and Ryan (2006) reported in a study that examined the design of CDSS to meet nurses needs, that the nurses expressed the need to "trust" the information. They wanted to know where the information came from. This is a significant finding as it points to the need to make evidence-based process to build practice maps transparent to users. Campion et al. also noted that a facilitator to successful CDDS usage included the nurse's trust in the recommendations made by the CDSS.

Dowding et al., (2009b) reported that the ability of nurses to adapt the technology also affected use. Some nurses felt that after repeated use of the algorithms, they had learned them and found them of little value. Some nurses discussed how they tailored the algorithms by directing the patient to answer questions in a specific order to get to a specific recommendation. Choi et al. (2011) reported that nurses wanted a system that allowed customized guidelines for patients.

Organizational factors affecting usage

Organizational factors have also been identified as influencing use of technology innovations such as CDSS guidelines. In a qualitative study examining chief nurse executives clinical information system (CIS) readiness and success factors, Piscotty and Tzeng (2011) reported that the majority of CNE responses were classified into the thematic areas of: champion support, staff preparation for change, training, organizational alignment, and planning, with the themes of culture, funding, access, usability, decision-making, and communication having the fewest responses. A new theme not previously identified in the model but clear in the CNE responses is the lack of vendor support.

Titler (2008) reported that members of a social system determine how fast and widely EBP guidelines are adopted and that auditing and feedback have shown a positive effect on changing behavior. Titler also suggested that organizational structure and factors may affect adoption and that leadership support is critical for promoting the use of EBP. Powell-Cope, Nelson, and Patterson (2008) when describing a model of technology use by nurses reported that organizational factors that may influence use include: policies, resources, culture, social norms, management commitment, training programs, and employee empowerment. Simlarly, Randell and Dowding (2010) reported that key themes to successful CDSS use include: adequate

resources, characteristics of the system, and adequate training. Additionally, the nurses reported that a supportive environment and desire to improve quality are keys to successful implementation

Nurses Use of CDSS Summary Synthesis

The literature review on CDSS was synthesized into four common themes or factors that influence nurses use of CDSS. These four areas are: clinician factors, patient factors, design factors, and organizational factors. These four areas were readily supported by the literature (See Table 3). Additionally the review readily revealed that there have been limited studies that have addressed CDSS and nursing. The majority of research on CDSS has tended to focus on physician usage and adoption. There has also been limited research on the adoption of clinical guideline content delivered through a CDSS.

Nurse CDSS usage factors were identified by Dowding et al. (2009a) and Dowding et al. (2009b) as an area that needs further research and exploration. The authors specifically stated that the relationship between nurse experience, knowledge base, and CDSS usage needs to be further studied. Randell, Mitchell, Dowding, Cullum, and Thomopson (2007) conducted a systematic review of nursing CDSS usage. Randell et al. (2007) reported that the evidence of CDSS usage to support nursing practice is limited. In the review, they were only able to locate eight studies that addressed the effects of CDSS on nursing performance and patient outcomes. Staggers, Weir, and Phansalkar (2008) conducted an integrative review of CDSS for nursing. Staggers et al. (2008) identified three gaps based on a review of literature surrounding CDSS and nursing. They noted that there is a lack of understanding of the knowledge development of CDSS to support nursing practice. The knowledge representation of nurse clinical decision-making in

CDSS is unknown. They also noted that the delivery of CDSS content must be further explored in order to support nurses' clinical workflow. In their review, only 31 studies were identified as relevant and only 13 focused directly on nursing.

Table 3. Synthesis of key finding: CDSSs literature review

Nursing Factors Affecting Usage	Study
Aligned with workflow	Campion et al. (2011); Choi et al. (2011); Courtney et al. (2008); Ernesater et al. (2009); Kowamoto et al. (2005);Piscotty et al. (2011); Saleem et al. (2005); Randell et al. (2010); Titler (2008); Weber et al. (2009); Weir et al. (2007)
Experience with system	Alquraini et al. (2007); Dowding et al. (2009a; 2009b)
Age	Alquraini et al. (2007); Powell-Cope et al. (2008); Titler (2008)
Education	Alquraini et al. (2007); Titler (2008)
Gender	Alquraini et al. (2007)
Experience in current role	Cho et al. (2010);Dowding et al. (2009a; 2009b); Powell-Cope et al. (2008)
Critical thinking	Titler (2008)
Patient Factors Affecting Usage	**Study**
Unfamiliar patient	Dowding et al. (2009a; 2009b); Randell et al. (2007)
Complex patient	Dowding et al. (2009a; 2009b); Randell et al. (2009)

(continued)

Table 3. Synthesis of key finding: CDSSs literature review (continued)

Organizational Factors Affecting Usage	Study
Leadership	Piscotty et al. (2011); Powell-Cope et al. (2008); Randell et al. (2010); Titler (2008)
Organization structure	Titler (2008)
Champions	Piscotty et al. (2011); Randell et al. (2010); Titler (2008)
Training	Piscotty et al. (2011); Randell et al. (2010); Powell-Cope et al. (2008)
Resources	Randell et al. (2010)
Vendor support	Piscotty et al. (2011)
Technology and Design Factors Affecting Usage	**Study**
Interface usability	Campion et al. (2011); Powell-Cope et al. (2008); Saleem (2005; 2007)
Flexibility	Cho et al. (2010); Choi et al. (2011); Dowding (2009a; 2009b); Powell-Cope et al. (2008); Saleem et al. (2005; 2007)
Access	Marshall, et al. (2011); Saleem et al. (2005)
Knowledge-base	Cho et al. (2010); Campion et al. (2011); O'Neill et al. (2006); Powell-Cope et al. (2008)

Literature Review Synthesis of Missed Nursing Care

A review of the literature was conducted to determine the breadth of understanding surrounding the phenomena of missed nursing care. Pub Med and the Social Science Index were two databases that were searched. The keywords used included: Nursing, care, missed, rationed, unfinished, and omission. Key words were combined to narrow search results to relevant articles that focused specifically on care omission of nurses. Manuscripts addressing omissions of nursing care, unfinished nursing care, rationed nursing care, and missed nursing care were included for review and synthesis. The time period searched was open ended, as the concept of missed nursing care is a relatively new concept.

The literature retrieved was synthesized into common themes. The common themes that emerged from the review of literature on missed nursing care include: (1) General knowledge of missed nursing care, (2) Hospital and nursing unit variation in missed nursing care, (3) Nurse and patient perceptions regarding missed nursing care, (4) Missed nursing care and teamwork, (5) Missed nursing care and job satisfaction, (6) Missed nursing care and staffing adequacy, and (7) Missed nursing care and outcomes. Each of the seven areas is discussed below with a summary synthesis of the gaps in knowledge regarding missed nursing care.

General knowledge of missed nursing care

The concept of missed nursing care was first explored in a qualitative study conducted by Kalisch (2006). Using focus groups with registered nurses (RNs), licensed practical nurses (LPNs), and nursing assistants (NAs) the purpose of the study was to find common types of missed nursing care and the subsequent reasons behind them. The nurses in the study responded that they were not always able to provide the needed care for each patient. The participants

reported a high level of guilt and regret when not able to provide all of the care their patients required.

Through analysis of the focus group transcripts nine themes of regularly missed nursing care emerged. These themes are: (1) ambulation, (2) turning, (3) delayed or missed feedings, (4) patient education, (5) discharge planning, (6) emotional support, (7) hygiene, (8) intake and output documentation and (9) surveillance. Similarly, seven themes for the reasons for missed care emerged from the analysis. These themes are: (1) too few staff, (2) time required for a nursing intervention, (3) poor use of existing staff resources, (4) not my job syndrome, (5) ineffective delegation, (6) habit, and (7) denial.

Missed nursing care was formally defined in a concept analysis conducted by Kalisch, Landstrom, and Hinshaw (2009). A concept analysis was needed as no definition of missed care was found in the extant nursing literature. The authors noted that other studies examined effects of missed care, but did not address it directly (Kalisch et al., 2009). Missed nursing care is conceptualized as a universal phenomenon and is generalizable to multiple clinical settings. Antecedents to missed care include: labor resources, material resources, and communication and teamwork, which interact with the nursing process and the nurse's own internal processes. Potential ramifications of missed nursing care are threats to patient safety. Thus, missed nursing care is defined as any aspect of required patient care that is omitted (either in part or whole) or delayed (Kalisch, et al., 2009).

Kalisch, Landstrom, and Williams (2009) conducted a descriptive study to determine what nursing care is commonly missed and the reasons why care is missed. Kalisch et al. (2009) examined missed care missed according to the Nursing Process and found that assessment was missed 44% of the time, intervention 73% of the time, and planning 71% of the time. The six

most commonly missed nursing care items were: (1) ambulation (84%), (2) assessing effectiveness of medications (83%), (3) turning (82%), (4) mouth care (82%), (5) patient teaching (80%), and (6) timeliness of PRN (as needed) medication administration. The least commonly missed nursing care items were patient assessments (17%) and bedside glucose monitoring (26%).

When examining the reasons for missed care, Kalisch et al. (2009) reported the three most commons reasons for missed care included: (1) labor resources (85%), (2) material resources (56%), and (3) communication (38%). In regard to labor resources the four items that make up this category: (1) unexpected rise in patient acuity, (2) urgent patient situations, (3) level of staffing, and (4) inadequate number of assistive personnel were reported as common reasons by greater than 80% of the respondents.

Lawless (2010) examined the similar concept of care rationing in a survey that examined indicators of workplace quality. Lawless defined care rationing as any situation in which care is delayed, omitted, or not completed at a satisfactory level due to workload pressures. In regard to rationed care, nurses reported 11 common patient care activities that were all ranked as often or very often rationed. The authors did not list the 11 common themes but indicated they included items such as: implementing planned care, patient surveillance, and completing documentation. When care was rationed due to workload pressures the nurses stated they adapted by working at an increased pace, missing breaks, staying past shift, taking work related stress leave, changing jobs, or leaving nursing.

Hospital and nursing unit variation in missed nursing care

Kalisch et al. (2009) also examined types and reasons for missed care across hospitals and units. The results indicated that there were consistently no significant differences in the

number of omissions of assessments and basic care. There were differences in interventions and missing plans across hospitals. Reasons for missed care revealed no significant difference in terms of labor resources. There were significant differences in communication and material resources.

When looked at by service, renal units had significantly more missed care in the areas of assessment, interventions, basic care, and planning compared to other units. Reasons for missed care in renal units showed no significant difference in material and labor resources, but renal units had more communication problems. Additionally, associate degree nurses (ADNs) reported more missed care than baccalaureate nurses (BSN) or diploma nurses.

Al-Kandari and Thomas (2009) conducted a survey study to examine factors that contribute to nursing task incompletion in five Kuwait general hospitals. Nursing task incompletion is a nursing care omission. The most common nursing activities that nurses were unable to complete included: (1) comfort talk with patient and family, (2) adequate documentation of nursing care, (3) oral care, (4) routine catheter care, and (5) starting or changing IV fluid on time. The results indicated that nursing activities were completed more often when the patient to nurse ratio was less than five. Bivariate analysis was used to examine the relationship between task completion and demographic variables. The analyses indicated that the nurses' educational background and age were related to completion of nursing care activities. Gender had no influence on nursing care activity completion.

Kalisch, Tschannen, Lee, and Friese (2011) in a survey study examined variation in missed nursing care across ten hospitals. In regard to the amount and type of missed nursing care that was frequently or always missed: (1) ambulation (32.7%), (2) attendance at care conferences (31.8%), and (3) mouth care (25.5%) were the most commonly reported. In regard to items

occasionally or rarely missed: (1) patient assessments (97.7%), glucose monitoring (97.6%), and vital signs (95.8%) were the most commonly reported.

Similarly, the reasons for missed care most commonly reported included: (1) inadequate labor resources (93.1%), (2) material resources (89.6%), and (3) communication (81.7%). In regard to the labor resources category an unexpected rise in acuity or patient volume was the most commonly (94.9%) reported reason for missed nursing care. Medications missing in materials resources (94.6%) and communication, specifically unbalanced patient assignments (91%) were also commonly reported reasons for missed nursing care.

The authors also examined relationships among unit and staff variables (Kalisch et al., 2011). Eight variables were found to be associated with increased amounts of missed nursing care. These variables include: (1) being female, (2) being older, (3) being a RN, (4) working day shift, (5) having more experience, (6) absenteeism, (7) perceived staffing adequacy, (8) and caring for more patients on the previous shift. Education level, weekly work hours, and type of unit were not significantly associated with increased missed nursing care.

Adjusted regression analysis was used to determine significant predictors of missed care (Kalisch et al., 2011). The significant predictors in the model were: (1) NAs with fewer years of experience reported less missed care compared to RNs, (2) night shift workers reported less missed care than day shift staff, (3) nursing staff who missed two or more shifts in the past three months reported more missed care, (4) those who cared for more patients in the previous shift reported more missed care, and (5) nursing staff that perceived staffing as adequate reported less missed care. Age and gender were not significant predictors of missed care in the regression model.

Kalisch, Gosselin, and Choi (2012) examined the differences in missed nursing care among units with the most missed nursing care and those with the least missed nursing care. Transcripts from focus groups with RNs were analyzed. There were 10 themes that emerged that described the differences between units with high and low amounts of missed nursing care. The 10 themes include: (1) staffing levels and adaptability, (2) communication, (3) collective orientation, (4), backup, (5) monitoring, (6) leadership, (7) long tenure, (8) unit layout, (9) trust, and (10) accountability.

Nurse and patient perceptions regarding missed nursing care

Kalisch (2009) conducted a survey study that examined RNs and NAs perceptions of the elements of missed nursing care and their reasons. RNs reported more missed care than NAs. Perceptions for missed care were only similar for five nursing care activities: (1) medication administration, (2) PRN (as needed) medication requests, (3) patient assessments, (4) focused reassessments, and (5) teaching about discharge planning. Registered nurses reported significantly more missed care for the remaining 19 items on the MISSCARE survey (See Appendix C for a list of all missed care items).

In regard to the reasons for missed care, staff and labor resources were reported the most by both RNs and NAs, but RNs felt this was a reason for more missed care than NAs. Registered nurses also identified an unexpected rise in patient volume, urgent patient situations, and admissions and discharges more frequently than NAs. Registered nurses and NAs did not differ in their reasons for missed care related to level of staffing and number of assistive personnel.

Gravlin and Bittner (2010) conducted a survey to examine RNs and NAs reports of missed nursing care. The most frequently missed nursing care activities were: (1) ambulation, (2) turning, (3) feeding, and (4) mouth care. The most commonly reported reasons for missed care

were related to labor resource factors and included: (1) an unexpected rise in patient acuity or volume, (2) inadequate number of assistive personnel, (3) heavy discharge/admission activity, (4) level of staffing, and (5) urgent patient situations.

The three common reasons for missed nursing care reported by RNs were related to nurses' ability to manage patient flow and rapidly changing patient and unit needs (Gravlin and Bittner, 2010). Additionally, RNs cited communication with the NA, specifically that care was not completed as a factor for increased missed nursing care. RNs also noted that communication breakdowns among healthcare personnel led to an increase in missed nursing care. An additional finding of this study was that 88 % of nurse managers stated that staff had reported a nursing care omission to them. The managers that received reports of nursing care omissions, 66.7% of them reported the occurrence of the omission as frequent (Gravlin and Bittner, 2010).

Kalisch, McLaughlin, and Dabney (2012) explored elements of missed nursing care that patients could report and the patients' perceptions on the extent and type of missed nursing care they experienced. A qualitative phenomenological design was used in the study. Patients were interviewed to answer two questions: (1) What is the patient's ability to assess elements of nursing care? and (2) To what extent care was missed? Items of missed care that patients could report were categorized into three areas (fully reportable, partially reportable, and not reportable.). Missed nursing care items were further categorized into the areas of frequently missed, sometimes missed, and rarely missed.

Fully reportable frequently missed nursing care activities that patients could identify included: mouth care, listening, and being kept informed. Nursing care activities that were sometimes missed included: response to call lights, response to alarms, meal assistance, and pain medication and follow-up. Bathing was reported as rarely missed. Partially reportable frequently

missed nursing care activities that patients could report included: ambulation, discharge planning, and patient education. Nursing care activities that were sometimes missed included: medication administration and repositioning. Vital signs and hand washing were identified as rarely missed. Missed nursing care activities that patients were unable to report included patient assessment, surveillance, and IV site care.

Missed nursing care and teamwork

Kalisch (2009) conducted focus groups to examine the underlying teamwork issues between RNs and NAs and the relationship to reasons for missed nursing care. The RNs felt there was not enough staff. They also reported that the NAs did not have an adequate knowledge base to understand the impact that missed nursing care activities have on patient outcomes. The RNs also stated that NAs would refuse to provide care. An additional theme identified by RNs was poor communication and that the NAs do not give them complete patient reports. In regard to the NAs perceptions, they felt that the RNs didn't believe them when they would report they completed a nursing care activity. The NAs also reported that they did not have enough time to complete nursing care activities. Additionally, the NAs stated that the RNs do not listen to them, and that they received no or late reports on their patients from the RNs.

Kalisch and Lee (2010) conducted a descriptive study to examine if the level of teamwork is related the amount of missed nursing care. Teamwork scores varied significantly by unit, intensive care units (ICUs) had higher teamwork scores than the other units. A negative relationship between missed care mean scores and teamwork was significant (r -.37, $p < .01$), indicating that higher teamwork scores are associated with less missed nursing care. Kalisch and Lee (2010) also reported that more missed care was associated with lower scores in: (1) trust, (2) having a team orientation, (3) having a shared mental model, and (4) team leadership.

Multiple regression analysis was conducted to examine predictors of missed care. Registered nurses perceived more missed care than NAs. Compared to staff working on the unit with less than six months of experience, staff that reported five or more years of experience reported more missed nursing care. Additionally staff that perceived staffing as adequate reported less missed nursing care.

Missed nursing care and job satisfaction

Rochefort and Clarke (2010) conducted a correlational survey examining the relationships between work environment, care rationing, job outcomes, and quality of care on neonatal units. The results indicated that more favorable work environments were related to lower levels of nursing care rationing. Specifically rationing of parental teaching, support, infant comfort care, discharge planning, and care coordination were 11% lower when nurse staffing and resource adequacy were rated one point higher. There was a 5.7% and 7.7% reduction in rationing of life support, technologically oriented nursing care, and patient surveillance between the best and worst ratings of nurse staffing and resource adequacy. A 4% per unit increase in nurse-physician relationships was related to a reduction in rationing of life support, technologically oriented nursing care, and patient surveillance. Rationing of care was an explanatory effect in the relationship between nurse-physician relationships and emotional exhaustion.

Tschannen, Kalisch, and Lee (2010) conducted a descriptive study examining the relationship between missed nursing care and RN intention to leave and turnover. Bivariate analysis indicated that larger amounts of missed care were associated with higher turnover rates. Larger amounts of missed care were associated with greater intention to leave. Multiple

regression analysis indicated that missed care was not found to be a predictor of nurse turnover, but was found to be a predictor of intention to leave.

Kalisch, Tschannen, Lee, and Salsgiver (2011) conducted a survey to explore the impact of missed nursing care on job satisfaction of RNs and NAs. Nursing staff that reported less missed nursing care had a greater satisfaction with their job and occupation. Regression analysis was used to determine predictors of satisfaction. In the two models tested, staffing adequacy and missed care were significant predictors of satisfaction. The analysis also revealed that perceptions of staffing adequacy were a significant predictor for both satisfaction variables (job and occupation). Additionally, it was found that nurses on ICUs were more satisfied than those on rehabilitation units.

Missed nursing care and staffing adequacy

Sochalski (2004) conducted a survey that examined the relationship between nursing staffing and the quality of nursing in hospitals. One concept examined in this study was "unfinished care", defined as the number of tasks left undone (Sochalski, 2004). Unfinished care, a related concept to missed nursing care is also considered a care omission. Sochalski (2004) reported that the quality of nursing care is significantly associated with the number of patients the nurse cares for, rates of unfinished care for the patients, and frequency of patient safety problems.

Kalisch, Tschannen, and Lee (2011) conducted a descriptive study with the aim of examining the relationship between staffing adequacy and missed nursing care. In bivariate analysis, hours per patient day (HPPD) and registered nurse HPPD (RNHPPD) were negatively associated with missed care. The higher the hours per patient day, the less missed nursing care

reported. Greater absenteeism was associated with higher reports of missed nursing care. Higher case mix index (CMI) was associated with lower reports of missed nursing care.

Multiple regression analysis was used to determine predictors of missed nursing care. Hours per patient day (HPPD) was a significant predictor of missed nursing care and along with the other variables in the model, experience (>5 yrs), absenteeism, CMI, and 9 dummy hospital variables, the total variance explained was 29.4%. The only variable in the model that was significant was HPPD. Thus, missed nursing care may partially explain the relationship between staffing levels and patient outcomes.

Missed nursing care and outcomes

Schubert, Glass, Clarke, Aiken, Schaffert-Witvliet, Sloane, and De Geest (2008) conducted a multi-hospital survey to examine the relationship of rationing of nursing care and patient outcomes. Overall, nurses in the study reported low levels of omitted care. Multilevel multivariate regression analysis indicated that implicit rationing of nursing care was a significant predictor of all six patient outcomes studied. The six patient outcomes examined in the study are: (1) patient satisfaction, (2) medication errors, (3) patient falls, (4) nosocomial infections, (5) critical incidents, and (6) pressure ulcers.

Kalisch, Tschannen, and Lee (2012) conducted a descriptive study examining the relationship between missed nursing care, staffing, and patient falls. Bivariate analysis indicated that HPPD was negatively associated with falls and higher missed care scores were associated with higher fall rates. Additional significant correlations were found related to the following elements of missed nursing care: (1) ambulation, (2) each shift patient assessment, (3) call light response, and (4) toilet assistance. Focused reassessment and CMI were not significantly associated with falls. Three regression analyses were conducted to examine if missed nursing

care mediated the relationship between HPPD and patient falls. The analyses indicated that missed nursing care is a mediator of the relationship between HPPD and falls.

Missed Nursing Care Summary Synthesis

The literature review conducted on missed nursing care was synthesized into seven common themes. The common themes that emerged from the review of literature on missed nursing care include: (1) General knowledge of missed nursing care, (2) Hospital and nursing unit variation in missed nursing care, (3) Nurse and patient perceptions regarding missed nursing care, (4) Missed nursing care and teamwork, (5) Missed nursing care and job satisfaction, (6) Missed nursing care and staffing adequacy, and (7) Missed nursing care and outcomes. These seven themes were readily supported by the literature (See Table 4).

Three main gaps were identified through the review of the literature. The three gaps are: (1) greater understanding of the impact on patient outcomes, (2) what are the specific or granular aspects of the labor resource component that leads to missed care, and (3) interventions to decrease missed care. Although, a relationship between patient outcomes and missed nursing care has been demonstrated, additional studies need to be conducted to determine the impact that missed nursing care has on additional patient outcomes such as cost and length of stay.

In regard to the labor resource component, a primary reason for missed care, a granular approach is needed to examine specific reasons for missed care in this component. One hypothesis is that increased patient acuity and volumes may lead to more frequent distractions and interruptions in care (Bittner et al., 2011). These distractions and interruptions may impact the RNs working memory thus contributing to an increase in missed nursing care. The third gap is that no specific interventions have been developed to address missed nursing care. One suggestion is the use of electronic care reminders delivered to nurses in EHRs. This intervention

is related to possible frequent interruptions and distractions related to inadequacy of labor resources, which may remind nurses to complete care that may be missed if no reminder is present.

Table 4. Synthesis of key findings: Missed nursing care literature review

General Knowledge	Study
Missed nursing care, unfinished care, nursing task incompletion, and nursing care rationing are all similar concepts. They are omissions of nursing care.	Al-Kandari et al. (2009); Kalisch, Landstrom, & Hinshaw (2009); Lawless (2010); Rochefort et al. (2010); Shubert et al. (2008); Sochalski (2004).
Top 5 missed nursing care activities: (1) ambulation, (2) assessing effectiveness of medications, (3) turning, (4) mouth care, & (5) patient teaching.	Al-Kandari et al. (2009); Gravlin et al. (2010); Kalisch, Landstronm, & Williams (2009).
Top 3 reasons for missed nursing care: (1) labor resources, (2) material resources, & (3) communication.	Al-Kandari et al. (2009); Gravlin et al. (2010). Kalisch, Landstronm, & Williams (2009).
Hospital and Unit Variation	**Study**
Differences in types of missed care:	
No difference is basic care items and missed nursing care.	Kalisch, Landstronm, & Williams (2009).
Nursing interventions and missing plans of care differed.	Kalisch, Landstronm, & Williams (2009).
Differences in Reasons for missed care:	
No difference in labor resources	Kalisch, Landstronm, & Williams (2009).
Difference in communication and material resources.	Kalisch, Landstronm, & Williams (2009).
Renal units had more missed nursing care	Kalisch, Landstronm, & Williams (2009).
Top 3 missed nursing care activities across hospitals: (1) ambulation, (2) assessing effectiveness of medications, & (3) mouth care.	Kalisch, Tschannen, Lee, & Friese (2011).
Top 3 reasons for missed nursing care across hospitals: (1) labor resources, (2) material resources, & (3) communication.	Kalisch, Tschannen, Lee, & Friese (2011).

(continued)

Table 4. Synthesis of key findings: Missed nursing care literature review (continued)

Nursing and Patient Perceptions	Study
RNs report more missed care than NAs	Kalisch (2009).
Similar perceptions of commonly missed care of RNs and NAs include: (1) medication administration, (2) prn medication requests, (3) patient assessments, (4) focused reassessments, & (5) teaching about discharge planning.	Kalisch (2009).
Labor resources most common reason reported for missed care by both RNs and NAs.	Gravlin et al. (2010); Kalisch (2009).
Patients could report many items of missed nursing care, but were unable to report patient assessment, surveillance, and IV site care.	Kalisch, McLaughlin, and Dabney (2012).
Teamwork	**Study**
Poor communication	Kalisch (2009).
Incomplete or no patient report	Kalisch (2009).
Lack of trust	Kalisch (2009).
Lack of understanding of roles	Kalisch (2009).
Negative relationship between teamwork scores and missed nursing care	Kalisch & Lee (2010)
Leadership	Kalisch & Lee (2010)
Shared mental model	Kalisch & Lee (2010)
Team orientation	Kalisch & Lee (2010)

(continued)

Table 4. Synthesis of key findings: Missed nursing care literature review (continued)

Job Satisfaction	Study
Missed nursing care is significant predictor of intention to leave.	Tschannen, Kalisch, & Lee (2010).
Nurses whom reported less missed care had greater job satisfaction.	Kalisch, Tschannen, Lee, & Salsgiver (2011).
Staffing adequacy and missed care are significant predictors of job satisfaction	Kalisch, Tschannen, Lee, & Salsgiver (2011).
More favorable work environments are related to lower levels of care rationing.	Rochefort & Clark (2010).
Staffing Adequacy	**Study**
HPPD is a significant predictor of missed nursing care.	Kalish, Tschannen, & Lee (2011).
As the number of patients cared for increases the amount of unfinished nursing care increases.	Sochalski (2004).
When patient to nurse ratio was less than 5:1 there is less care rationing.	Al-Kandari & Thomas (2009)
Outcomes	**Study**
Missed care mediates the relationship between HPPD and fall rate.	Kalisch, Tschannen, & Lee (2012).
Nurse rationing is associated with the following patient outcomes: (1) patient satisfaction, (2) medication errors, (3) patient falls, (4) nosocomial infections, (5) critical incidents, and (6) pressure ulcers	Schubert et al. (2008).

Chapter III

Methods

Study Design

The specific aims of this study were accomplished with a descriptive design using adjusted correlations and comparisons. Descriptive designs are appropriate when a phenomenon of interest has not been thoroughly studied (Brink & Wood, 1998). The descriptive design of this study is appropriate, as the relationship between the impacts of HIT on nursing practice have not been widely studied (Dykes et al., 2007; Goldzweig et al., 2009). Although this is a descriptive design, missed nursing care will serve as the outcome variable for data analysis. The primary independent variable for the study is the level of use of nursing care reminders. A mediating variable I-HIT will also be examined. Additionally, several control variables will be collected in order to adjust for extraneous variance. Please see Tables 1 and 2 for conceptual definitions and empirical indicators of all variables.

Sample

A convenience sample (N = 165) of medical and/or surgical, intensive care, and intermediate care registered nurses working on acute care hospital units was used in this study. The sample was obtained from one large Midwestern teaching hospital that agreed to participate in the study. All eligible nursing units (N = 19) were included in the study.

Power analysis

Multiple regression was conducted with 4 predictor variables, with a power of 0.80, and a small effect size of 0.20. Power analysis for multiple regression was evaluated with G*Power 3.1

and indicates a minimum sample size of 33 for each model, but the plan was to collect data on 150 participants to ensure the detection of a small effect. (See Figure 2 for output).

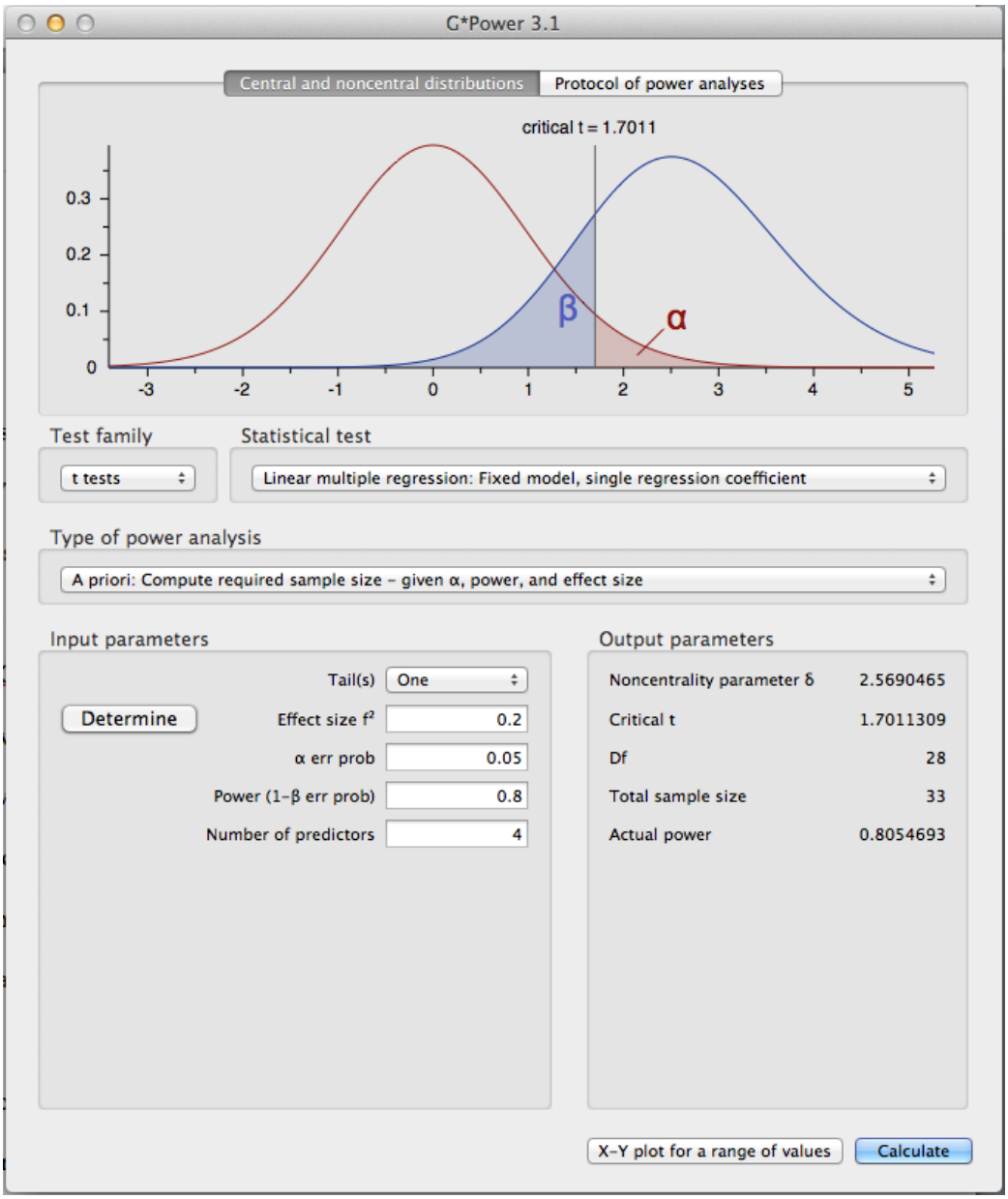


Figure 2. Power Analysis Output

Inclusion/Exclusion Criteria

Inclusion criteria for the study included that participants must be a staff registered nurse and take a daily patient assignment on the unit in which they work. The EHR must have been

implemented for least six months, with nursing care reminders present in the EHR. Exclusion criteria for this study included unit employees that are non-registered nurse employees (e.g. LPN, PCA, clerks, etc.), registered nurses not assigned a patient assignment (e.g. managers, case managers, educators, nursing instructors, etc.), and student nurses.

Instruments

MISSCARE Survey

The Missed Nursing Care Survey (MISSCARE) is a two-part survey (See Appendix C) developed by Beatrice Kalisch in 2009. In the current study, only part A of the survey will be used. Part A of the survey contains 24-items that are designed to measure elements of missed nursing care (Kalisch & Williams, 2009). Part A of the tool asks the participants to rate the frequency of missed nursing care on their unit, including themselves (Kalisch & Williams, 2009). The rating is based on a five-point scale with anchors of "never" and "always". Part-B is used to measure the reasons for missed care and will not be used in this study. Content validity has been established through testing by three panels of staff nurses with a content validity index (CVI) of 0.89 (Kalisch & Williams, 2009). Reliability for part A of the tool was established using test-retest reliability; the Pearson Product Moment Correlation Coefficient was 0.87 [$p <$ 0.001; confidence interval, 0.76 – 0.93] (Kalisch & Williams, 2009).

The MISSCARE survey also contains a demographic questionnaire. This questionnaire will be used collect data regarding nurse characteristics. The demography questionnaire will be modified, as two characteristics of interest in the proposed study are not included in the survey. The two items are number of years as a registered nurse and amount of experience with current EHR.

Nursing Care Reminder Usage Survey

A nursing care reminder usage survey was developed and used in this study (See Appendix E). The survey asked participants 12 questions regarding their usage and perceptions of nursing care reminders. The rating is based on a five-point scale with anchors of "never" and "always" with a N/A choice. Two specific questions of interest were the nurses self-reported level of use of nursing care reminders and the types of nursing care reminders they use.

The survey was pilot tested with two groups of practicing nurses. The first pilot contained 10 nurses from an information systems super-user group at a community hospital. The second pilot contained 17 nurses from a Magnet unit representative group at a large academic medical center. The participants in both pilots felt the survey had face validity. They stated the survey measured RN usage of nursing care reminders. The average time to complete the survey was 18.5 minutes in pilot 1 and 13.76 minutes in pilot 2. (See Tables 5 & 6 for a descriptive analysis of pilot one and two.)

In pilot 1, there was a range of responses for all questions except 1.2 (print-out of activities) and 1.6 (electronic list not in EHR). Both of these questions were included in pilot 2 for further evaluation. The majority of the questions had a mean between occasionally and frequently utilized. The range of the means for the questions was a Min of 1 to a Max of 4.1. Question 1.9 - Electronic checklist for documenting care that serve as a reminder, was removed as it was found to be redundant as this was already included in item 1.5.

In pilot 2, there was a range of responses for all questions. The majority of the questions had a mean between occasionally and frequently utilized. The range of the means for each of the items was a minimum of 1.93 and a maximum of 4.00. An additional item (1.10) was added to the survey as nurses indicated they received "Text page reminders".

Table 5

Nursing Care Reminders Survey: Pilot one descriptive statistics

Variable	*M*	*SD*	*Min*	*Max*
NCRS 1.1	2.00	1.16	1	4
NCRS 1.2	1.00	0.00	1	1
NCRS 1.3	3.80	0.79	3	5
NCRS 1.4	3.40	1.35	1	5
NCRS 1.5	4.10	0.88	3	5
NCRS 1.6	1.00	0.00	0*	1
NCRS 1.7	3.11	1.17	0*	5
NCRS 1.8	3.40	0.70	2	4
NCRS 1.9	2.90	1.52	1	5
NCRS 1.10	3.20	0.79	2	5
NCRS 2	3.00	1.16	2	5
NCRS 3	3.50	1.51	1	5

Note: NCRS = Nursing Care Reminders Survey; * not included in calculation of mean and standard deviation (0 = not applicable response).

Table 6

Nursing Care Reminders Survey: Pilot two descriptive statistics

Variable	*M*	*SD*	*Min*	*Max*
NCRS 1.1	3.50	1.37	0*	5
NCRS 1.2	2.87	1.77	0*	5
NCRS 1.3	3.88	1.31	0*	5
NCRS 1.4	3.50	0.97	0*	5
NCRS 1.5	3.56	1.32	0*	5
NCRS 1.6	1.93	1.14	0*	4
NCRS 1.7	3.93	1.34	0*	5
NCRS 1.8	4.00	1.20	0*	5
NCRS 1.9	3.86	1.10	0*	5
NCRS 2	3.75	1.00	2	5
NCRS 3	3.56	0.96	2	5

Note: NCRS = Nursing Care Reminders Survey; * not included in calculation of mean and standard deviation (0 = not applicable response).

I-HIT Scale

The I-HIT scale was conceptualized and developed by Patricia Dykes and Charlotte Weaver in 2005 (See Appendix D for scale). The scale is composed of 29-items contained in four subscales (Dykes, et al., 2007). The first subscale is the general advantages of HIT and contains items that are related to HIT facilitating patient-centered communication by providing access to data and information within the context of acute care workflows. The second subscale is workflow implications of HIT subscale and contains items that are related to how HIT supports nurses' role as integrator and communicator. The third sub-scale is information tools to support communication tasks and contains items that are related to the availability and use of HIT tools that optimize and support the work of nurses. The last subscale is information tools to support information tasks and contains items related to the appropriate use of information tools to support efficient communication. (Dykes et al., 2007)

Content validity assessment by five nursing informatics content experts was performed. They utilized a two-point scale to rate each items relevance under the theme in which it was listed. This resulted in the 43-item scale with a content validity index (CVI) of 1.0. The 43-items achieved a content validity index beyond the 0.05 significance level. (Dykes et al., 2007)

Internal consistency reliability was determined using Cronbach's alpha for each of the 43 items on the initial scale. Those items with an inter-item correlation of less than 0.35 were removed (n = 11) and resulted in a 32-item scale. The analysis was repeated and any additional items with an inter-item correlation less than 0.35 were removed. Two additional items were found to have an inter-item correlation of 0.8, which indicates redundancy and were removed. This resulted in the final 29-item scale (Dykes et al., 2007).

Principal components analysis (PCA) with Varimax rotation and Kaiser Normalization was used for factor analysis of the data. Eigen values exceeding one were found for five items that explained 62% of the variance, which was consistent with the theoretical prediction (Dykes et al., 2007). The five-component model was found to be parsimonious, but was not easily interpretable, so a four-component model was developed (Dykes et al., 2007). A scree plot was generated for the four-component model, the plot leveled off after the fourth factor, which indicated that appropriateness of the four-component model. The Varimax rotation revealed strong loadings for the four factors and significant side loadings of 17 items. These items were kept with the factor associated with the strongest loading and that was conceptually aligned with the statement. The four factors from the PCA explained 58.5% of total variance (Dykes et al., 2007).

Internal consistency using Cronbach's alpha was 0.95 for the 29-item scale. Internal consistency of the four subscales ranged from 0.80 to 0.89. The four subscales of the scale are:

1. General advantages of HIT (9 items) - α 0.88; 14% of variance
2. Workflow implication of HIT (8 items) - α 0.89; 16.1% of variance
3. Information tools to support communication tasks (7 items) - α 0.86; 12.6% of variance
4. Information tools to support information tasks (5 items) - α 0.80; 12.1% of variance (Dykes et al., 2007)

The authors examined concurrent validity by examining correlations between mean total subscale scores and the scores from the Overall Satisfaction Impact of Health Information Technology (OSI-HIT) scale (Dykes et al., 2007). The OSI-HIT scale was developed along with the I-HIT scale to measure overall satisfaction with HIT to measure concurrent validity (Dykes et

al., 2007). The author's hypothesized that a high score on the OSI-HIT would be correlated to high scores on the I-HIT scale (Dykes et al., 2007). Moderate to large correlations were noted between the OSI-HIT scale and the four sub-scales of the I-HIT (Dykes et al., 2007). This was interpreted as providing support for criterion related validity.

The I-HIT scale is scored using a six-point Likert-type scale and a not applicable choice. The possible choices range from one to six (strongly disagree to strongly agree) and not applicable. The authors suggested that higher scores indicate greater nurse agreement with statements on the impact of HIT in the care they provide, their work at the bedside, and the impact on interdisciplinary communication (Dykes et al., 2007).

Other Variables

Additionally, staffing adequacy and acuity were collected. These variables were collected at the unit level. These two variables were collected using a standardized form developed by the principal investigator (PI). (See Appendix F for form).

Procedure

Institutional review board (IRB) approval was obtained from both the University of Michigan and the study hospital. The IRB application received an expedited review as no participant identifying information was being collected. There was minimal chance for harm to subjects as they completed an anonymous survey. The participants survey data was downloaded into SPSS for data analysis. The data was stored on a password-protected computer that is accessible only to the PI. The completed online surveys were deleted after the data was downloaded.

Implied consent from participants was obtained if the nurses completed the online surveys. An informational only consent form describing the study was included in the participant

email and survey directions, but participants were not required to sign and return the form. The online survey included study instruments; consent information, and detailed directions. The surveys were administered as an online survey with a link sent to participants via email (See Appendix G for email).

The survey was administered using the Qualtrics survey software. The survey is anonymous, as no identifying information was collected. Email addresses were used to send the survey to each participant in the study. The survey was sent out to each unit separately so5 the PI could determine the response rate by unit. Email addresses were obtained with assistance from the hospital research sponsor. Email addresses were associated with the data collected. Respondent burden is expected to be minimal as the instruments and demographic survey are short and took less than 20 minutes in the pilot of the instruments.

Flyers were placed in high visibility areas to remind nurses to complete the survey (See Appendix I for email). A reminder email was sent to all nurses twice a week via email. All surveys were due at 4 weeks. Units that had a response rate greater than or equal to 60% received a unit incentive of a large Edible Arrangement for each shift. Unfortunately, no unit had a response rate of 60% or greater.

Review of Research Questions

Relationships

1. Controlling for CMI, RNHPPD, and nurse characteristics examine the following relationships:
    a. Is there a relationship between nurses' level of use of reminders and missed nursing care?
    b. Is there a relationship between I-HIT scores and missed nursing care?

Mediating Relationships

2. Does I-HIT mediate the relationship between nursing care reminders and missed nursing care?

Comparisons

3. Controlling for CMI, RNHPPD, and nurse characteristics compare the following:
    a. Do nurses who report higher levels of use of nursing care reminders have reports of decreased or less missed nursing care?
    b. Do nurses who have more positive perceptions of I-HIT on their practice have reports of decreased or less missed nursing care?

Data Analysis

Data was analyzed using SPSS 21. The data was cleaned and descriptive analysis was conducted to examine normality and linearity of variables. This was accomplished through interpretation of descriptive statistics and visual examination of graphs and plots. Assumptions for regression and multivariate analysis were also assessed (i.e., independence, normality, linearity, and multicollinearity).

Stepwise regression entry was used to determine nurse characteristics to include in the regression models. Analysis indicated that only gender was a significant predictor of missed nursing care. The remaining nurse characteristic variables (See Table 2 for characteristics) were not found to be significant predictors of missed nursing care, and thus, were excluded from the analysis. The data was then split into two groups by using the 50^{th} percentile for each of the following variables: I-HIT scores and level of use of reminders to allow for the analysis of comparisons. The transformed variables were named nursing care reminders (high/low) and I-HIT (high/low).

Hierarchical multiple regression analysis with control variables was used to determine adjusted relationships between the variables of interest, examine mediating relationships, and make comparisons among groups. Significance tests and beta coefficients were analyzed and interpreted to determine the study outcomes. Control variables were entered into the model first to control for the effect of these variables and then the primary independent variables were entered (Polit, 2010).

In order to test for mediation, the method described by Baron and Kenny (1986) was used. According to Baron and Kenny (1986), a variable is considered a mediator (See Figure 3) when three criteria are met: (a) variation in the independent variable accounts for significant variation in the mediator variable (path *a*), (b) variation in the mediator variable accounts for significant variation in the dependent variable (path *b*), and (c) when paths a and b are controlled there is significant reduction in the variance between the independent variable and dependent variable (path *c*). The method consists of using three regression equations: (1) the independent variable must affect the mediator in the first equation, (2) the independent variable must affect the dependent variable, and (3) the mediator must affect the dependent variable (Baron and Kenny, 1986). When these three criteria are met, the relationship between the independent variable and the dependent variable must be less in the third equation than in the second (Baron and Kenny, 1986).

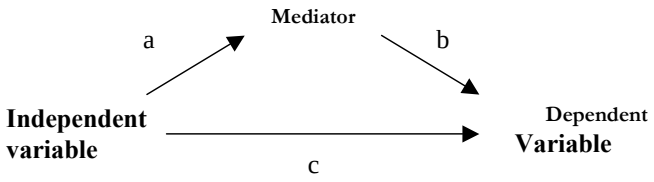


Figure 3. General mediation model

Finally, the I-HIT scale and Nursing Care Reminders survey will be tested for reliability based on the participants of this study. This will be accomplished using Cronbach's alpha. The alpha value for all analyses is set at $p \leq 0.05$.

Chapter IV

Results

Demographics

The sample (N = 165) consisted of staff nurses employed at a local hospital in the Midwestern United States during Fall 2012. The majority of the respondents held a Bachelor's Degree as their highest level of education (n = 114, 69.1%), with 67.1% (n = 110) of those participants having a Bachelor's of Science degree in Nursing (BSN). The majority of respondents were female (n = 145, 87.9%) and between the ages of 25 and 34 (n = 61, 37.0%). Over half of the participants in the study (n = 104, 63.0%) worked on a medical surgical unit. See Table 7 for further descriptive analysis of demographic characteristics.

Table 7
Demographic Characteristics of Sample

Characteristics	Total sample (N = 165)	
	n	%
Age		
Under 25 years old	23	3.9
25 to 34 years old	61	37.0
35 to 44 years old	38	23.0
45 to 54 years old	26	15.8
55 to 64 years old	16	9.7
Over 65 years old	1	0.6
Gender		
Male	20	12.1
Female	145	87.9
Experience in role		
Up to 6 months	8	4.8
Greater than 6 months to 2 years	40	24.2
Greater than 2 years to 5 years	35	21.2
Greater than 5 years to 10 years	23	13.9
Greater than 10 years	59	35.8
Experience as Registered Nurse (RN)		
Up to 6 months	8	4.8
Greater than 6 months to 2 years	36	21.8
Greater than 2 years to 5 years	35	21.2
Greater than 5 years to 10 years	25	15.2
Greater than 10 years	61	37.0
Experience with current Electronic Health Record (EHR)		
Up to 6 months	5	3.0
Greater than 6 months to 2 years	45	27.3
Greater than 2 years to 5 years	78	47.3
Greater than 5 years to 10 years	25	15.2
Greater than 10 years	12	7.3
Highest Education Level		
Associates degree	44	26.7
Bachelors degree	114	69.1
Graduate degree	7	4.2
Employment Status		
Full-time	154	93.3
Part-time	11	6.7

Univariate Analysis

Total missed nursing care scores ranged from a low of 24 to max of 84 (M = 56.09; SD = 11.79) out of a total possible score of 120. Nursing care reminders total scores ranged from a low of 11 to max of 50 (M = 29.98; SD = 8.11) out of a total possible score of 60. Total I-HIT scores ranged from 28 to 171 (M = 129.32; SD = 22.94) out of a total possible score of 174. CMI ranged from a low of 4.87 to high of 18.24 (M = 9.09; SD = 4.54). RNHPPD ranged from a low of 1.11 to a high of 6.99 (M = 2.25; SD = 1.51).

Unadjusted Correlations

The relationship between missed nursing care (as measured by the MISSCARE Survey) and nursing care reminders (as measured by the Nursing Care Reminders Survey) was examined using Pearson product-moment correlation coefficient. There was a negative correlation between these two variables, r = -.183, p < .05, higher levels of reminder usage are associated with lower levels of missed nursing care.

The relationship between missed nursing care (as measured by the MISSCARE Survey) and the impact of health information technology (as measured by the IHIT Survey) was also investigated using Pearson product-moment correlation coefficient. A negative correlation was discovered between these two variables, r = -.313, p < .01, a positive outlook on the impact of information technology was associated with lower levels of missed nursing care.

The relationship between nursing care reminders (as measured by the Nursing Care Reminders Survey) and the impact of health information technology (as measured by the IHIT Survey) was examined using Pearson product-moment correlation coefficient. There was a positive correlation between the two variables, r = .336, p < .01, a positive view of information technology was associated with higher levels of reminder usage.

Adjusted Correlations

Adjusted relationships using hierarchical multiple regression indicated significant negative relationships between missed nursing care and nursing care reminders and I-HIT. Preliminary analyses were conducted to ensure that there were no violation of the assumptions of normality, linearity, multicollinearity, and homoscedasticity. The first regression model was calculated to determine if there was a significant adjusted relationship between missed nursing care and nursing care reminders. CMI, RNHPPD, and gender were included as covariates in step one of the equation, and explained 8.3 % of the variance in missed nursing care. After entry of nursing care reminders at step two, the total variance explained by the model as a whole was 15.2 %, F (4,160) = 7.15, $p < .001$. Nursing care reminders explained an additional 7 % of the variance in missed nursing care after controlling for CMI, RNHPPD, and gender, R^2 change = .07, F change (1,160) = 12.94, $p < .001$. In the final model, only CMI (beta = -.40, $p = .001$), gender (beta = .16, $p = .034$), and nursing care reminders (beta = -.28, $p < .001$) were statistically significant.

The second regression model was calculated to determine if there was a significant adjusted relationship between missed nursing care and I-HIT. CMI, RNHPPD, and gender were included as covariates in step one of the equation, and explained 8 % of the variance in missed nursing care. After entry of I-HIT at step two, the total variance explained by the model as a whole was 18.8 %, F change (4,153) = 8.85, $p < .001$. I-HIT explained an additional 11 % of the variance in missed nursing care after controlling for CMI, RNHPPD, and gender, R^2 change = .11, F (1,153) = 20.33, $p < .001$. In the final model, only CMI (beta = -.34, $p = .003$) and I-HIT (beta = -.34, $p < .001$) were statistically significant.

Mediation

The impact of Health Information Technology (IHIT) was hypothesized in this study as a mediating variable in the relationship between nursing care reminders (NCRS) and missed nursing care. To satisfy the requirements for mediation, 3 regression equations were computed. To establish mediation, the following conditions must be satisfied: (a) NCRS must affect IHIT; (b) NCRS must affect missed nursing care in the second equation; and (c) IHIT must affect missed nursing care in the third equation. When equations 1 and 3 are controlled, a previously significant relationship between the independent and dependent variables is no longer significant, indicating strong demonstration of mediation (Krause et al., 2010).

In equation 1, IHIT, the mediator variable, was regressed on the predictor variable, NCRS. As noted in Figure 4, results indicated that NCRS was significantly associated with IHIT ($F_{156} = 19.84$, $p < .001$). NCRS explained 11.3% of the variance in IHIT scores.

In equation 2, missed nursing care, the outcome variable, was regressed on the predictor variable, NCRS. NCRS was significantly associated with missed nursing care ($F_{163} = 5.67$, $p = .018$). NCRS explained 3.4% of the variance in missed nursing care.

In the final equation, missed nursing care, the outcome variable, was regressed on the predictor variable, NCRS, and the mediator variable (IHIT). IHIT negatively affected missed nursing care ($t = -4.12$, $p < .001$), explaining 9.8% of variance in missed nursing care. With IHIT present, the predictor (NCRS) was no longer significant ($t = -.70$, $p = .48$). Thus, the reduced direct association between NCRS and missed nursing care when IHIT was in the model supported the hypothesis that IHIT was at least 1 of the mediators in the relationship between NCRS and missed nursing care.

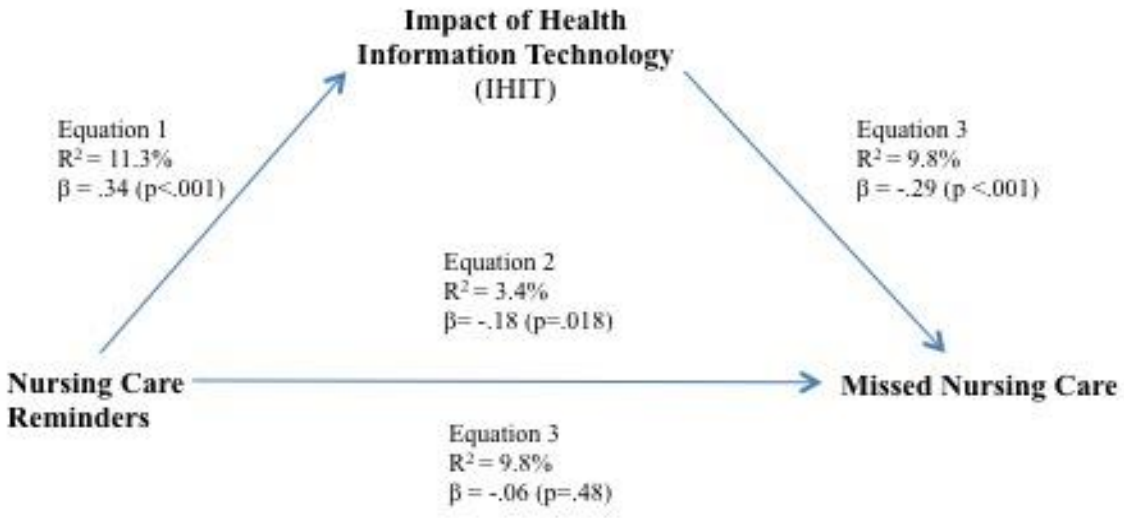


Figure 4. Test of the mediation model with regression analyses.

Comparisons

Adjusted relationships using hierarchical multiple regression using the two transformed variables of nursing care reminder usage (high/low) and I-HIT (high/low) indicated significant negative relationships between missed nursing care and nursing care reminders and I-HIT. Preliminary analyses were conducted to ensure that there were no violation of the assumptions of normality, linearity, multicollinearity, and homoscedasticity. The first regression model was calculated to determine if there was a significant adjusted relationship between missed nursing care and nursing care reminders (high/low). CMI, RNHPPD, and gender were included as covariates in step one of the equation, and explained 8.3 % of the variance in missed nursing care. After entry of nursing care reminders at step two, the total variance explained by the model as a whole was 12.9 %, F (4,160) = 5.94, p < .001. Nursing care reminders explained an additional 4.6 % of the variance in missed nursing care after controlling for CMI, RNHPPD, and gender, R^2 change = .046, F change (1,160) = 8.48, p = .004. In the final model, only CMI (beta

= -.34, p = .004), gender (beta = .15, p = .046), and nursing care reminders (beta = -.22, p < .004) were statistically significant.

The second regression model was calculated to determine if there was a significant adjusted relationship between missed nursing care and I-HIT (high/low). CMI, RNHPPD, and gender were included as covariates in step one of the equation, and explained 8 % of the variance in missed nursing care. After entry of I-HIT (high/low) at step two, the total variance explained by the model as a whole was 15 %, F change (4,153) = 6.75, p < .001. I-HIT explained an additional 7 % of the variance in missed nursing care after controlling for CMI, RNHPPD, and gender, R^2 change = .07, F (1,153) = 20.33, p = .001. In the final model, only CMI (beta = -.26, p = .023) and I-HIT (beta = -.27, p = .001) were statistically significant.

Instrument Reliabilities and Validity

Test-retest reliability of the MISSCARE Survey was not conducted in the current study. Reliability for part A of the MISSCARE Survey was established using test-retest reliability in a previous study; the Pearson Product Moment Correlation Coefficient was 0.87 [p < 0.001; confidence interval, 0.76 – 0.93] indicating more than adequate reliability (Kalisch & Williams, 2009). Reliability of the Nurse Care Reminders Survey in the current study was calculated using Cronbach's Alpha. The Cronbach's Alpha in this study was 0.84, indicating more than adequate reliability. Reliability of the I-HIT scale for the current study was calculated using Cronbach's Alpha. The Cronbach's Alpha in this study was 0.94, indicating more than adequate reliability.

The MISSCARE Survey has established content validity (Kalisch & Williams, 2009). Content validity of the MISSCARE survey was established through testing by three panels of staff nurses with a content validity index (CVI) of 0.89 (Kalisch & Williams, 2009). Five nursing informatics content experts established the content validity of the I-HIT survey (Dykes et al.,

2007). The experts utilized a two-point scale to rate each items relevance under the theme in which it was listed. This resulted in the 43-item scale with a content validity index (CVI) of 1.0. The 43-items achieved a content validity index beyond the 0.05 significance level (Dykes et al., 2007). Face validity of the Nursing Care Reminders Survey was established in the current study using two pilot surveys. The survey was pilot tested with two groups of practicing nurses. The first pilot contained 10 nurses from an information systems super-user group at a community hospital. The second pilot contained 17 nurses from a Magnet unit representative group at a large academic medical center. The participants in both pilots felt the survey had face validity. They stated the survey measured RN usage of nursing care reminders.

Chapter V

Discussion

Unadjusted and Adjusted Correlations

Unadjusted and adjusted correlations support the research questions that there is a relationship between nursing care reminder usage and missed nursing care, and that there is a relationship between I-HIT and missed nursing care. The relationships are negative indicating that nurses that rate higher levels of usage and I-HIT have decreased reports of missed nursing care. This makes sense as those whom have higher scores on the I-HIT have positive perceptions about the impact of technology on their practice.

This finding is significant as nursing care reminders may be an effective intervention to decrease missed nursing care. Although, missing one instance of care may not impact overall patient outcomes, the cumulative effects may have a negative impact on patient outcomes. The use of nursing care reminders to alert nurses to cumulatively missed care may be an intervention to significantly reduce the amount of missed nursing care. Additionally, nurses with higher I-HIT scores may be more apt to use nursing care reminders that may result in decreased missed care.

A limitation of nursing science is that the relationship between missed nursing care and nursing care reminders has not been previously studied. This study was the first to study these relationships. It was hypothesized by Dykes et al. (2007) that nurses whom scored higher on the I-HIT would be more likely to use the clinical information systems and have improved outcomes. This is consistent with the findings in this study. Nurses that use reminders have decreased amounts of missed nursing care.

An alternate explanation for this finding may be that nurses whom are more likely to use the EHR may be more likely to complete their nursing care activities. This is compared to nurses that may be less accountable and neither use the EHR consistently or make sure they complete all nursing care activities needed for their patients. Additionally, this study was conducted in one hospital. The hospital culture may have an effect on the use of the EHR reminders. As a result of the culture the nurses in this study may be more likely to use the reminders due to organizational pressures and also may have decreased amounts of missed nursing care to begin with.

Mediation

Analysis of mediation again supports the research question that I-HIT mediates the relationship between reminder usage and missed nursing care. Nurses that use reminders more frequently and have higher perceptions about the impact of HIT on their practice have less missed nursing care than nurses that use reminders alone.

This is a significant finding as nurses that have more positive perceptions of the impact of HIT on their practice have less missed nursing care than nurses that just use reminders alone. This is important as healthcare organizations can utilize the I-HIT to assess whether or not their nurses have positive perceptions about the technology systems they are required to use. Organizations can then target specific system design or workflow changes to improve nurses' perceptions of the impact of HIT on their practice.

A limitation of nursing science is that the mediating relationship between missed nursing care, I-HIT, and nursing care reminders has not been previously studied. This investigation was the first to study this mediating relationship. Although, Dkyes et al. (2007) hypothesized that nurses that have positive perceptions of the impact of HIT on their practice would be more likely to use the technology. Dykes et al. (2007) hypothesis is supported by the findings from this

study. Courtney et al. (2008) found that CDSS must be aligned with the nurse's workflow if they are to use the systems. Saleem et al. (2005) reported that one facilitator to using CDSS by nurses was to integrate the reminders into the nurses' workflow.

An alternate explanation for this finding is that nurses that use nursing care reminders already have more positive perceptions of the impacts of HIT on their practice. Nurses that utilize the system may be more accountable and therefore have decreased amounts of missed nursing care to begin with. Organizational or cultural factors may also have an impact on nurses' perceptions of HIT on their practice.

Comparisons

Comparisons of nurses that report higher levels of reminder usage also have decreased reports of missed nursing care. This was also the result for I-HIT. Nurses that reported higher positive impacts of HIT on their practice had decreased reports of missed nursing care.

This finding is important because nurses that have decreased amounts of missed nursing care may have better patient outcomes. The use of nursing care reminders may then have an overall effect in decreasing the amount of missed nursing. Missed nursing care or care omissions are much more common than errors of commission (AHRQ, 2011). Encouraging nurses to use nursing care reminders may thus result in a net decrease in care omissions and improved patient quality and safety.

A limitation of nursing science is that the relationship between missed nursing care and nursing care reminders has not been previously studied. This study was the first to examine these comparisons. Kalisch (2012) found that missed nursing care was a mediating factor in patient falls. Choi et al. (2011) reported that nurses consistently stated CDSS contributed to improved nursing outcomes. Thus, if nurses utilize reminders more often they may have less missed

nursing care, which can have an impact on outcomes such as, patient falls. Reducing care omissions, which are considered much more common than errors of commission (AHRQ, 2011) may have an overall improvement in quality of care. Ernesater et al. (2009) reported that nurses found CDDS to be quality improving.

An alternate explanation is that nurses that utilize the system are already highly accountable and therefore may already have a decreased amount of missed nursing care. These nurses may have well developed delegation and teamwork skills that result in effective and efficient nursing care. These efficient teams may therefore have less missed care to begin with. The organization in which these nurses work may also have an impact. The organizational culture may direct nursing usage of the EHR, nursing care activity completion, and influence perceptions about the technology system on practice.

Model Evaluation

The conceptual model used in this study was evaluated to determine if the proposed relationships existed. There were significant adjusted relationships between reminder usage, I-HIT, and Missed nursing Care. Also, significant relationships were found between CMI, RHPPD, and gender. Additionally, a mediating relationship was found between nursing care reminders, I-HIT, and missed nursing care. These findings supports the conceptual model that I-HIT mediates the relationship between nursing care reminder usage and missed nursing care.

Implications

The findings from this study have many practical implications. First of all, I-HIT can be used to assess the impact of technology on nursing practice. This information can then be used to evaluate HIT to determine where changes may need to occur to be better aligned with clinician workflow. Workflow alignment is important, as it has been suggested the poor workflow

alignment has resulted in unintended consequences of HIT (Aarts et al., 2007; Harrison et al., 2007). The unintended consequences can result in new errors that have not been previously encountered before the implementation of the HIT (Ash, 2007, Han et al., 2005; Koppel et al. 2005).

A second implication is that properly designed nursing care reminders may influence usage and thus decrease the amount of missed nursing care. Reminders that nurses find helpful may result in increased usage of the reminders. There must be a balance between the quality and quantity of nursing care reminders. Reminders that are redundant or not seen as important may be missed or ignored. Missed or ignored reminders may then result in an increase in missed nursing care. One suggestion is that future designers of reminders may need to look at the cumulative effects of missed nursing care rather than individual instances of missed care. Patients that are not ambulated once may not be at a disadvantage in their healing compared to a patient that has missed multiple instances of ambulation. This cumulative effect needs to be further investigated.

A third implication is that nurses' need to be taught and encouraged in the proper usage of nursing care reminders. Nursing care reminders are adjuncts to clinical reasoning and are not a replacement for it. Although a patient may have many reminders, they may still require additional nursing care that is at the discretion of the individual nurse. Nurses using reminders properly may result in decreased missed nursing care. This may be especially true with novice nurses that may need the reminders to serve as cues of what nursing activities are appropriate for a particular patient. Additionally, more seasoned nurses may find reminders useful in validating their clinical reasoning. The reminders may be helpful for seasoned nurses whom are encountering a patient with a unique or unfamiliar plan of care. This is consistent with findings

from the study conducted by Dowding et al. (2009a) in which they found novice nurses used the system more frequently and more seasoned nurses used the CDSS when they encountered an unfamiliar or complex case.

Finally, it was found that I-HIT mediates the relationship between nursing care reminder usage and missed nursing care. This information is useful in that designers of HIT systems need to keep in mind that impacts of the technology will influence usage. Many times systems are not designed to match the workflow of nurses. Systems built with redundant or impertinent reminders may be ignored. System designers must study which reminders nurses find most useful and which reminders result in the best quality outcomes.

Strengths & Limitations

Limitations and Anticipated Problems

Limitations of this study include threats to internal and external validity. A threat to internal validity is that the sample size was not extremely large. The investigator addressed this by determining sample size a priori using a small effect size and limiting analysis to no more than four IVs in regression analysis. Selection bias is also a possible threat to internal validity for this study, as a convenience sampling method was used. Therefore, the relationships that were examined in this study may be attributed to sample characteristics rather than the true relationship between the variables of interest. This threat has been addressed by determining sample size a priori as stated above and including nurse characteristics as covariates in the analyses. Instrumentation may also be a threat to internal validity of this study. The PI has addressed this by selecting instruments that have proven validity and reliability and are specifically designed to be used with registered nurses.

Threats to external validity are present because of the fact that the sample may not be representative of the population and therefore the results may not be generalizable beyond the sample. The PI has taken this into consideration and has addressed this by examining the possible relationship of the nursing care reminders and missed nursing care in more than one nursing unit.

An additional limitation is that two of the covariate variables are measured at the unit level. The primary level of measurement in this study is the registered nurse. Thus there may be nesting of data. This may violate the assumption of independence of linear regression. The risk is that a significant effect may not be detected. This was not the case in this study as a significant relationship between the primary IV and DV was established.

Future Research

This study was a first step in establishing a linkage between the uses of nursing care reminders and missed nursing care. This study must be repeated with a larger sample to determine if the relationship holds. Second, the study needs to be repeated in multiple hospitals. The study hospital may have been extremely adept at using reminders, but other hospitals may have a different experience. The present study was also only conducted with one EHR, examining the relationships in organizations with different EHRs is also recommended.

A concept analysis on what constitutes nursing care reminders is also needed. The extant literature is void on this concept. A concept analysis should be conducted to determine the types of nursing care reminders and determine empirical definitions in order to measure them. Reminders are not unique to nursing, so literature from other disciplines may also need to be investigated. This needs to be conducted to determine if there are similar or different concepts that are associated with reminders.

Ultimately, the goal of nursing care reminder research is to develop investigator designed reminders as interventions. These interventions will be designed to target specific missed care items. This is a lofty goal and a long-term endeavor as the different types of reminders nurses' use needs to be clearly defined. Also, before this can occur, exploratory research needs to be conducted to determine which types of reminders are effective in decreasing the specific types of missed nursing care.

Conclusion

This study was a first step in determining if HIT has an impact on nursing care process. The study was successful in that a significant relationship was found between nursing care reminders usage and decreased amounts of missed nursing care. Additionally I-HIT was found to be a mediator of reminder usage and missed nursing care. These are significant findings that can be used to encourage nurses to use nursing care reminders, helpful for information system designers when designing nursing care reminder, and helpful to healthcare organizations in assessing the impact of technology on nursing practice. It is imperative that missed nursing care be decreased to improve patient and organization outcomes. Nursing care reminders may be a viable solution to reduce missed nursing care in a technology rich healthcare environment.

APPENDICES

Appendix A

Clinical Decision Support System Literature Review Matrix

Clinical Decision Support System Literature Review Matrix

Source	Setting	Sample	Design	Instruments	Key Findings	Strengths	Limitations
Alquraini; 2007	Ministry of Health Hospitals in Kuwait	Random sample of 574 nurses (92.3% response rate)	Survey	Questionnaire to measure characteristics and attitudes of nurses toward computerized healthcare information systems	**ANOVA** revealed statistically significant differences in attitudes in relation to nationality, level of education, pervious experiences in computer use, and computer skills (P<.05). Multiple regression showed that gender (females), nationality (non-Kuwaiti), higher education levels, and longer duration of computer use were statistically significant predictors of positive attitudes toward computerized health information system (P<0.05)	Large random sample	Occurred in one county with majority of nurses from another country (Philippines)
Campion; 2011	Surgical and trauma ICUs in academic	49 hours of observation and 49 instances of	Direct observation and unstructured	None	The authors noted significant barriers to use. These include: lack of reminders,		Small sample, unstructured

	medical center	RNs using intensive insulin therapy; 16 patients observed; 25 nurses observed; 27 nurses interviewed	interviews of RNs		inaccurate user interface design. Similarly the authors noted facilitators to successful use. These include: nurse trust in the CDSS with clinical judgment.		interviews.
Cho, 2010	Two teaching hospitals in Seoul Korea	32 RNs, only 18 completed study, 56% participation rate	Repeated measures factorial design (split-plot design) and feedback from nurses	2 written scenarios	User preferences for display of information in CDSS differed significantly between novice and expert nurses. The novice nurses wanted to see all possible problems for patients, whereas expert nurses only wanted the top five problems. The nurses stated that the CDSS was well organized and facilitated patient problem identification. The nurses also felt that automatics suggestions and data		Small sample, low participation by sample, conducted in foreign country with different health system than USA

					driven approaches to assessments were desirable features of the system. The nurses felt that the CDSS was tedious and difficult to input data and the display for data input was too complicated.		
Choi; 2011	Six hospitals in a single university medical system in Korea	37 nurses	Qualitative focus-groups	Discussion guidelines developed for focus groups	The nurses consistently stated that CDSSs can contribute to improving nursing outcomes by standardizing nursing care. The nurses wanted a system to remind them of scheduled care, assesses deleterious changes in patient condition, and acuity level. Nurse wanted a system that allowed customized guidelines for patients.		Small sample, conducted in foreign country with different health system than USA

Courtney; 2008			Review of literature on CDSS		Nursing CDSS have been designed for information management rather than knowledge generation. User participation in the design and implementation of the system increase the likelihood of successful implementation and utilization of the system. CDSS must fit within workflow of clinician. They must feel that CDSS address a particular and important concern for clinical practice. System integration may be a factor in user acceptance of system. Redundant data entry in disparate system may decrease user acceptance.		

Dowding; 2009a	Secondary analysis: Telephone triage center; Case analysis: primary care, NHS walk-in center,	Secondary analysis: 53 qualitative interviews of nurses working in telephone triage system in UK; Case analysis: 80 observations of nurse-patient consultations and 11 interviews with nurses.	Secondary analysis: Secondary data analysis of qualitative interview data. Data analyzed using framework analysis Case analysis: two case site analyses. Data analyzed using thematic content analysis Other: No conceptual framework or model to guide study.	Not indicated but referred to previous study for additional information	Two main themes: Nurse integration of CDSS and effect of nurses' experience on how the CDSS was used. Integration: Nurses had integrated knowledge obtained from previous CDSS encounters to inform their decisions or they had learned the underlying algorithms of the CDSS. Experience: Nurses tended to use the CDSS recommendation when they first started and had little experience in their role. As the nurses gained more experience they were less likely to follow the guidance contained within the CDSS and use their own professional	Interviewed and observed nurses in practice that actually were using a CDSS to inform their practice. Observed nurses in a variety of settings.	Small sample size. Evaluated only the outpatient setting. Conducted in foreign country with different health system than US. Did not utilize conceptual framework or model to guide study.

					judgment and override recommendations if they felt it was appropriate. Experience nurses still valued CDSS and utilized it with unfamiliar cases or as a memory aid. Valued as a "safety-net"		
Dowding; 2009b	4 NHS Trusts in England	115 nurse/patient consultations and 55 interviews with nurses	Multiple case site study using non participant observation of nurse/patient consultations		CDSS systems used in a variety of ways by nurses: recording information, monitoring patient's progress, and confirming decisions already made. Nurses' experience with decision and technology affected how they used a decision support system and whether or not they over-rode recommendations made by the system. The ability of nurses to adapt the technology also affected use. If a		Length of time between data collection and publication. 2001 – 2002 data collection and publication 2009. There may have been significant changes since that time.

					nurse was not familiar with a patient they often utilized the CDSS recommendations. Some nurses felt that after repeated use of the algorithms they had learned them and found them of little value. Some nurses discussed how they tailored the algorithms by directing the patient to answer questions in a specific order or answer.		
Dykes, P.; 2007	Acute-care	Lit review: number of articles selected not reported Telephone focus group: 5 NI content experts from HIMSS NI user group.	Instrument development and psychometric evaluation; Item development: critical lit review, telephone focus groups, transcript	Developed the I-HIT scale as part of study	Instrument development: five themes emerged: 1. Interdisciplinary communication; 2. Information access; 3. Practice effectiveness and efficiency; 4. Interdisciplinary relationships; 5. Workflow implications of HIT; 50 survey items abstracted from qualitative analysis;	Strengths: Findings consistent with conceptual framework;	Limitations: Self-reported survey; non-probability sample method; unable to determine response rate; only 48.5% of respondents to psychometri

		<u>Psychometric evaluation:</u> non-probability snowball sampling method used; unable to calculate response rate; 1,760 responses (681 dropped, 1079 used)	analysis; qualitative content analysis; <u>Conceptual framework:</u> Coiera's Communication-Information Continuum (C-IC)		43 of the 50 scored as relevant for a content validity index (CVI) of 1.0. Achieved a CVI beyond the 0.05 level of significance and were retained. <u>Psychometric evaluation:</u> Cronbach's alpha was used to include items with an alpha of greater than .35. 29 items retained. Four factors from Principle components analysis explained 58.5% of total variance and are consistent with Coiera Model. Alpha of 29 item scale was 0.95 and reliability of subscales ranged from 0.80 to 0.89. Four Scales: 1. Workflow implications (16.1% of var; α 0.89) 2. General		c evaluation survey were direct care providers.

					advantages of HIT (14% of var; α 0.88) 3. Info tools/communication tasks (12.6% of var; α 0.86) 4. Info tools/info tasks (12.1% of var; α 0.80)		
Ernesater; 2009	Telephone advice call centers	Eight registered nurses in Sweden	Qualitative content analysis	Semi-structured interview guide	Nurses experienced their work with decision support as supporting, inhibiting, and quality improving. Found CDSS simplified work, complemented their knowledge, gave them security, and enhanced their credibility. Theme identified is that system strengthened their practice, but at the same time controlled and inhibited their professional judgment. The preferred		

					working with the system. They described that the CDSS cannot replace their knowledge and competence and that is should be considered complementary. Reported that system was incomplete, sometimes in conflict with their own opinion, and controlling. They felt system ensured quality of tele-nursing.		
Garg; 2005			Systematic review of effects of CDSS on practitioner performance and patient outcomes		Reviewed 100 studies. CDSS improved practitioner performance in 62 or 64% of studies. This included studies on diagnostic systems, reminder systems, disease management system, drug-dosing systems or prescribing systems. 52 trials assessed 1 or more patient outcomes, of		

					which 7 or 13% reported improvements. Improved performance was associated with CDSS that automatically prompted users vs those that the user has to initiate (success in 73% vs 47%) and studies in which authors developed the CDSS software (success in 74% vs 28%)		
Hunt; 1998			Systematic review of computer-based clinical decision support system on physician performance and patient outcomes		68 controlled trials reviewed. Effects on performance were assessed in 65 studies and 43 found benefit (66%). This included studies on drug dosing systems, diagnostic aids, preventative care systems, and CDSS for other medical care. Six of 14 studies assessing patient outcomes found a benefit. Of the remaining eight		

					only 3 had a power greater than 80% to detect for clinically important effect.		
Kawamoto ; 2005			Systematic review of trials to identify features that are critical to CDSS success		70 studies included; Decision support systems significantly improved clinical practice in 68% of trials. Four system features identified as contributing to clinical improvements. These include: automate provision of decision support as part of clinician workflow, provision of recommendations rather the just assessments, provision of decision support at the time and location of decision making, and computer based decision support. Of the 32 systems possessing all four features, 30 (94%)	Searched more than 10,000 articles (thorough) , reviewed literature for relevant expert opinion on system features that determine success, used two independe nt reviewers for study selection and data abstractio n.	Used binary outcome measure rather than a continuous measure, could not adjust for variations in size of outcomes, pooled different types of CDSS in regression analysis.

					improved clinical practice.		
Marshall; 2011	13 bed ICU in teaching hospital in Australia	6 to 17 RNs depending on stage of data collection	Instrumental case design using concurrent verbal protocols, Q methodology and focus groups	Q methodology sort distribution	Nurse preferred information sources are from other nurses and colleagues. Electronic resources were not utilized as much because they were perceived as less accessible and too much time to access information.		Varried sample size, only in one hospital in foreign country with different health system than USA.
O'Cathain; 2007	NHS 24 triage center in Scotland	542 nurses	Descriptive	Questionnaire to measure attitudes toward risk	Attitudes toward risk varied greatly among nurses. 27% agreed that nurses should not take risk with a physical illness where 17% disagreed. After case-mix adjustment there was some evidence that nurses' attitudes towards risk affected decisions but this was inconsistent and unconvincing. Much of the decision-making remained unexplained.	Provides evidence that there is variation among nurses making decisions with CDSS	Instrument did not perform well under psychometric evaluation.

O'Neill; 2006	Not identified	9 nurses from a local healthcare system and 3 senior-leve nursing students from local baccalaureat e nursing program.	Focus-group and thematic analysis	Scenario development and 4 high-level questions designed to promote critical thinking	Several nurses expressed the need to "trust" the information. "Where does this information come from?" This points to need to make evidence-based process to build practice maps transparent to users. Clinician must be able to trust the system to provide accurate and up to date information. This was also apparent in nurses need for actual data rather than an interpretation of data.		Nurses could not examine all system data and may have felt constrained by limited data
Piscotty; 2011	6 hospitals owned and/or operated by a national faith-based healthcare organization	6 Top-nursing leaders	Qualitative descriptive thematic analysis using grounded theory	Semi-structure interview guide	In regard to CIS readiness, the majority of CNE responses were classified into the model thematic areas of: champion support, staff preparation for change, training, organizational alignment, and planning with the		Small sample, respondents all from same parent organization

					themes of culture, funding, access, usability, decision-making, and communication having the fewest responses. A new theme not previously identified in the model but clear in the TNL responses is the lack of vendor support.		
Powell-Cope; 2008			Integrated literature review on patient care technology		Factors that influence the use of technology: Organizational factors: policies, resources, culture, social norms, management commitment, training programs, and employee empowerment Characteristics of nurses: age, experience, mindset about technology/attitudes, self-efficacy, attention, fatigue,		

					sensory inputs, perception, goals, intention to use, knowledge Physical environment: lighting, noise, architectural features Technology characteristics: reliability, validity, ergonomic design, output display, input mechanism, interface, compatibility with other technologies		
Randell; 2010	Four site: Anticoagulation management clinic, spinal assessment clinic, walk-in center, and respiratory center	124 observations of nurse/patient interaction, 36 patient interviews, 55 nurse interviews, and 18 interviews with managers	Multiple case study design	Observation protocol, semi-structured questionnaire	Key themes that emerged from the analysis indicated that in order for a system to be successful clinician engagement is necessary. Additional themes identified include: adequate resources, characteristics of the system, and adequate training. Additionally the nurses reported that a		Case study design in only 4 clinics. Conducted in foreign country with different health system then USA.

					supportive environment and desire to improve quality are keys to successful implementation		
Randell; 2009	Primary care	76 primary care nurses and observations of 410 consultations carried out by 70 primary care nurses	Supplementary secondary data analysis		Many of the nurses felt there was a need for decision tools to ensure consistently in practice. Nurses stated that they always followed the guidelines and they had memorized them and as such stated they were working off them even when not looking at them. Working with the guidelines occurred less frequently and were often utilized in unfamiliar cases. Guidelines would sometimes be checked after the event to ensure that they had taken the correct action. The nurses stated that they had helped develop the guidelines and the		Length of time between data collection and publication. 2001 – 2002 data collection and publication 2009. There may have been significant changes since that time.

					wanted national guidelines to be more user-friendly and to be able to adapt them to meet their needs.		
Randell; 2007	ICU, ambulatory clinic, telephone triage	Systematic review: 100 nurses and 24,000 patients, 7761 articles identified through lit search. Excluded 7418, reviewed remaining 343 + 49 identified through hand searching and expert contacts. 383 excluded, 9 included in review, 8	Systematic review	Utilized Cochrane Effective Practice and Organization of Care Group data collection checklist for validity assessment	<u>Nurses using CDSS compared to those that did not:</u> Three studies, one study showed improved performance while another it showed poorer performance, no study found an impact of CDSS on patient outcomes. <u>Nurses using CDSS compared with other health professionals:</u> In the five studies, three RCTs found no significant difference in patient outcomes with anticoagulation management between nurses and physicians. CDSS was found to be effective in two studies that looked at		

					triage and improved performance as it reduced GP workload when nurses used CDSS. One study suggests that CDSS is detrimental to patient outcomes, while another suggests it is beneficial to some outcomes. Benefits of CDSS are inconclusive and need further investigation.		
Saleem; 2007	Simulation; lab	16 intake nurses in outpatient clinic setting	Simulation experiment to examine impact of 4 design modifications to CR software: learn ability, usability, efficiency, and workload	survey, and semi-structure debriefing interview guide	Redesign of clinical reminders increase learn ability for first-time users as measured by time to complete first CR, completion time for two of five patient scenarios, usability of three groups of questions from survey instrument, and two of six workload subscales of the NASA Task Load Index (TLX) survey: Mental workload and	Utilized multiple measures	Low sample size, only test one CR system, participants first-time users of system, one of authors played role of patient in simulation and may have influenced results

					frustration. Learn ability time difference significant at $p < 0.001$ Efficiency time to complete was not statistically significant for three of the five scenarios. Usability scores statistically significant at $p < .05$ ease of use and overall satisfaction and $p < .001$ average response across usability constructs Workload - significant main effect on workload subscales at $p < .001$ but no significant main effect of overall design type on workload Modest design modifications to existing CR software positively impacted variables that likely		

					increase the willingness for first-time nursing users to adopt and consistently use CR Designed to address barriers identified in previous study: learn ability, efficiency, usability, and workload		
Saleem; 2004	Outpatient primary care clinics in 4 VA Medical Centers	35 nurses and 55 physicians mid-level practitioners	Observational study		**Barriers** to using system optimally included: lack of coordination between nurses and providers, using the reminders while not with the patient which impaired data acquisition and/or implementation of recommended actions, workload, lack of reminder flexibility, and poor interface usability. **Facilitators** included: limiting number of reminders at a site, strategic location of		

					the computer workstations, interaction of reminders into workflow, and ability to documents system problems and receive prompt administrator feedback		
Staggers; 2008			Integrated literature review on decision-support systems for nursing		31 studies identified as relevant only 13 focused directly on nursing. Nursing activity not addressed. Mechanics of providing CDSS to nurses has not been well explained Mechanism of action for CDSS interventions is unknown.		
Titler; 2008			Integrated literature review on EBP implementation		Adoption of EBP in health care settings involves complex interrelationships among EBP topics, organizational social system characteristics,		

					and individual clinicians. The rate and extent of adoption is interplay among these relationships. CDSS that support practice have a positive effect on aligning practices with evidence base. Clinical systems need to provide the evidence base at the point of care and need to integrate CDSS that integrates evidence for use in clinical decision making. There is still more that needs to be learned about how best to implement evidenced based information through electronic clinical information systems. Members of social system determine how		

					fast and widely EBP are adopted. Auditing and feedback have shown a positive effect on changing behavior. Characteristics of users such as education, practice specialty, and views of innovativeness may influence adoption of EBP although findings are equivocal. Nurses disposition towards critical thinking is positively correlated with research use. Org structure and factors may affect adoption. EBP must be aligned with workflow to foster adoption Leadership support is critical for promoting		

					use EBP		
Weber; 2009	Critical care units	33 nurses (23) and physicians (10) interviewed regarding the APACHE III CDSS	Qualitative descriptive using grounded theory		Nurses and physicians are motivated to use system when it allows them to forecast potential outcomes of decisions prior to actually making those decisions. When system decision was congruent with that of clinician prediction the clinician was more likely to incorporate the system recommendation into practice. Nurses were more apt to use system once they found out they could use the data to influence physician decisions. System was used to support or back-up the clinical decisions that were made.		

Weir; 2007	10 Veterans Administration Medical Centers	88 primary care clinicians; 14 nurses, 53 physicians, 8 pharmacists, 2 dieticians, 3 clerks, and 8 social workers	Observation and semi-structure interviews	Semi-structure interview guide	System must be designed to allow for fast and accurate decisions.	Multiple site study interviewing multiple types and levels of clinicians	

Appendix B

Missed Nursing Care Literature Review Matrix

Missed Nursing Care Literature Review Matrix

Source	Setting	Sample	Design	Instruments	Key Findings	Strengths	Limitations
Al-Kandari and Thomas, 2009	Medical surgical units in 5 governmen t general hospitals in Kuwait	780 nurses	Exploratory survey	International Hospital Outcomes Survey	The most common nursing activities that nurses were unable to complete included: (1) comfort talk with patient and family, (2) adequate documentation of nursing care, (3) oral care, (4) routine catheter care, and (5) starting or changing IV fluid on time. The results that nursing activities were completed more often when the patient to nurse ratio was less than five. Bivariate analysis was used to examine the relationship between task completion and demographic variables. T analyses indicated that the he nurses' educational background and age was related to completion of nursing care activities. Gender had no influence on nursing care activity completion.		Conducted in 5 hospitals in Kuwait. Self-report by nurses.

Gravlin, 2010	16 med/surg units in 3 hospitals in northeast.	241 RNs and 99 NAs, 42.6% response rate	Quantitative survey design	MISSCARE Survey 2; delegation questionnaire	Most frequently missed care items were ambulation, turning, feeding, and mouth care. Top six reasons for missed care were related to labor resource factors included: unexpected rise in patient acuity or volume, heavy discharge/admission activity, level of staffing, and urgent patient situations. Top 3 reasons were related to nurses ability to manage patient flow and rapidly changing patient and unit needs. Additionally, RNs cites communication with the NA that care was not completed as a factor. Communication breakdowns were also noted as a reason for increased missed care. 88 % of nurse managers reported that care omission had been reported to them by staff. Of those with reports, 66.7% reported the occurrence of the omission	Finding consistent with previous studies conducted by Kalisch et al.	Study conducted in 3 hospitals, small convenience sample

					as frequent.		
Kalisch, 2006	Medical surgical units in two hospitals	107 RNs, 15 LPNs, and 51 NAs 25 focus groups	Qualitative study utilizing focus groups	Not stated	Missed nursing care: nurses responded that they were not always able to provide the needed care for each patient. The participants reported a high level of guilt and regret when not able to care for their patients. 9 themes of regularly missed care emerged from analysis: (1) Ambulation, (2) Turning, (3) Delayed or missed feedings, (4) patient education, (5) discharge planning, (6) emotional support, (7) hygiene, (8) intake and output documentation and (9) surveillance 7 themes for the reasons for missed care emerged		

					from the analysis: (1) too few staff, (2) time required for a nursing intervention, (3) poor use of existing staff resources, (4) not my job syndrome, (5) ineffective delegation, (6) habit, and (7) denial		
Kalisch, Landstrom, Hinshaw, 2009	Theoretical paper	Theoretical paper; grounded in research literature of nursing and healthcare	Concept analysis of missed nursing care	Used Walker and Avant's modified 8 step process from Wilson	No definition of missed care found in literature; similar concept "unfinished" care discussed by Sochalski (2004). Other studies examined effects of missed care, but did not address it directly. Missed care is conceptualized as a universal phenomenon and is generalizable to multiple clinical settings. Antecedents to missed care include: labor resources, material resources, and communication and teamwork witch interact with the nursing process and the nurses own internal processes.		Based on limited research primarily one study conducted by Kalisch (2006)

					Consequences of missed nursing care are threats to patient safety. Missed nursing care is defined as any aspect of required patient care that is omitted (either in part or whole) or delayed. Missed nursing care is an error of omission.		
Kalisch and Williams, 2009	35 medical, surgical, rehab, and ICU units in 4 acute care hospitals	459 and 639 staff nurses in two studies	Development and psychometric testing of MISSCARE survey	MISSCARE survey	The Missed Nursing Care Survey (MISSCARE) is a two-part survey developed by Beatrice Kalisch in 2009. In the proposed study, only part A of the survey will be used (see Table 1). Part A of the survey contains 22-items that are designed to measure elements of missed nursing care (Kalisch & Williams, 2009). Part A of the tool asks the participants to rate the frequency of missed nursing care on their unit, including themselves (Kalisch & Williams,		Study only conducted in 4 hospitals, self-report may include bias, actual care was on observed.

					2009). The rating is based on a four-point scale with anchors of "rarely" and "always" and a not applicable choice. Part-B is used to measure the reasons for missed care and will not be used in this study. Content validity has been established through testing by three panels of staff nurses with a content validity index (CVI) of 0.89 (Kalisch & Williams, 2009). Reliability for part A of the tool was established using test-retest reliability, the Pearson Product Moment Correlation Coefficient was 0.87 [$p < 0.001$; confidence interval, 0.76 – 0.93] (Kalisch & Williams, 2009).		
Kalisch, Landstrom, Williams, 2009	3 hospitals; 28 in-patient units	459 registered nurses	descriptive	MISSCARE survey	Missed care missed by nursing process: 1. Assessment 44% 2. Intervention 73% 3. Planning 71% 6 most commonly missed		

					items were ambulation (84%), assessing effectiveness of medications (83%), turning (82%), mouth care (82%), patient teaching (80%). Least missed items were patient assessments (17%) and bedside glucose monitoring (26%) Reasons for missed care: 1. Labor resources 85% (specifically: unexpected rise in patient acuity, urgent patient situations, level of staffing, and inadequate number of assistive personnel) 2. Material resources 56% 3. Communication 38% Analysis across hospitals showed there was consistently no significant differences in the number of omissions of assessments and basic care. There were differences in interventions and missing plan across hospitals.		

					Reasons for missed care revealed no significant difference in terms of labor resources. There were significant differences in communication and material resources. When looked at by service renal units had sig more missed care in assessment, interventions, basic care, and missed planning compared to other units. Reasons for missed care in renal units showed no significant difference in material and labor resources, but renal units had more communication problems. ADN nurses report more missed care than BSN or diploma grads.		
Kalisch, 2009	18 units in 1 hospital	RNs (633), NAs (121)	Survey and focus groups	MISSCARE Survey Parts A & B	RNs reported more missed care than NAs. Perceptions for missed care were only similar for 5 items (med admin, prn med requests, patient assessments, focused reassessments, and		

					teaching about discharge planning). RNs reported significantly more missed care for the remaining 19 items on the MISSCARE survey. Reasons for missed care: Staff and labor resources was the most commonly reported by both RNs and NAs, but RNs felt this was a reason for more missed care than NAs. RNs also identified unexpected rise in patient volume, urgent patient situations, and admissions and discharges more frequently. RNs and NAs did not differ on level of staffing and number of assistive personnel. Focus group reasons for missed care: RNs: not enough staff, NAs not having knowledge base, NAs refuse, poor communication, NAs do not give complete report NAs: RNs don't believe us, they don't have enough		

					time, RNs do not listen, no or late report		
Tschannen, Kalisch, and Lee, 2010	10 hospitals, 110 medical, surgical, rehab, intermediate and intensive care units in Midwest	RNs 3143, LPNs 83, and NAs 943	Cross-sectional descriptive study	MISSCARE survey; Collection of turnover, intent to leave, and staffing data	Bivariate analysis indicated that larger amounts of missed care was associated with higher turnover rates. Larger amounts of missed care were associated with greater intention to leave. Multiple regression analysis indicated that : Missed care was not found to be a predictor of nurse turnover, but was found to be a predictor of intention to leave.		Hospitals of similar size and location. Measure of missed care is based on perceptions
Kalisch and Lee, 2010	50 medical, surgical, intermediate, intensive care, and rehab units in 4 hospitals located in the midwest	1719 RNs, 491 NAs	Cross-sectional descriptive study	MISSCARE Survey and Nursing Teamwork Survey	Teamwork scores varied significantly by unit, ICUs had higher teamwork scores than the other units. Negative relationship between missed care mean scores and teamwork were significant (r -.37, $p < .01$). More missed care was associated with trust, team orientation, shared mental model, and team leadership. The higher the		

					score on the NTS the less missed care. Predictors of missed care: RNs, those with tenures greater than equal to 5 years, absenteeism, and staffing adequacy.		
Kalisch, Tschannen, and Lee, 2011	10 hospitals, 110 medical, surgical, rehab, intermediate and intensive care units in Midwest	4288, RNs (73.5%), LPNs (1.9%), NA (22%), Nurse Manager (2.5%)	Cross-sectional descriptive study	MISSCARE survey, HPPD, Skill mix, education and experience, absenteeism, CMI	HPPD was a significant predictor of missed nursing care, other variables in the model experience (>5 yrs), absenteeism, CMI, and 9 dummy hospital variables explained 29.4% of the variance in the model, but only HPPD was significant. Missed nursing care may explain, in part, the relationship between staffing levels and patient outcomes. HHPD and RNHPPD were negatively associated with missed care. Greater absenteeism was associated with higher missed care. Higher CMI was associated with lower missed care.		
Kalisch, Tschannen, Lee,	10 hospitals, 110	RNs (3143),	Survey method	MISSCARE Survey Part A	Amount and type of missed care:		Collected from self-response survey; not

and Friese, 2011	medical, surgical, rehab, intermediate and intensive care units in Midwest	NAs (943)		& B	Frequently or always missed: Ambulation (32.7%), attendance at care conferences (31.8%), and mouth care (25.5%). Items occasionally or rarely missed: Patient assessments (97.7%), glucose monitoring (97.6%), and vital signs (95.8%) Reasons for most missed care: Inadequate labor resources (93.1%), material resources (89.6%), and communication (81.7%). In regard to labor resources unexpected rise in acuity or patient volume was the top reason (94.9%). Medications missing in materials resources (94.6%), and communication specifically unbalanced patient assignments (91%) 8 variables associated with		certain that all possible explanatory variables present in model

					missed care were found: (1) female, (2) older, (3) RNs, (4) working day shift, (5) more experienced, (6) nurses whom missed shifts in last 3 months, (7) perceived staffing inadequacy, (8) and care for more patients in the previous shift reported more missed nursing care. Education level, weekly work hours, and type of unit were not significantly associated with missed care. Predictors of missed care are: NAs with fewer years of experience reported less missed care compared to RNs, Night shift workers reported less missed care than day shift, nursing staff who missed 2 or more shift in the past three moths reported more missed care, those who cared for more patients in the previous shift reported more missed care, nursing staff that perceived staffing as		

					adequate reported less missed care, and age and sex were not sig associated with missed care.		
Kalisch, Tschannen, Lee, and Salsgiver; 2011	10 hospitals, 110 medical, surgical, rehab, intermediate and intensive care units in Midwest	3135 RNs and 939 NAs	Survey	MISSCARE survey	Nursing staff reporting less missed nursing care had great satisfaction with their job and occupation. In both models staffing adequacy and missed care were significant predictors of satisfaction. Perceptions of staffing adequacy were a sig predictor for both satisfaction variables. Nurses on ICUs were more satisfied than those on rehab units.		Hospitals of similar size and location. Measure of missed care is based on perceptions
Kalisch, Gosselen, Choi, 2012	10 specific patient care units; 5 units with highest ratings of missed care and 5 units with lowest ratings of missed care (total of 5	Ten focus groups made up of 10 to 12 RNs	Qualitative using focus groups		10 themes that describe differences between units with high and low amounts of missed nursing care emerged: (1) staffing levels and adaptability, (2) communication, (3) collective orientation, (4), backup, (5) monitoring, (6) leadership, (7) long tenure, (8) unit layout, (9) unit		

	hospitals) out of 10 hospitals, 110 medical, surgical, rehab, intermediate and intensive care units in Midwest				layout, and (10 trust). Those with less staffing ("It gets a little stressful when we are short…but we work it out")		
Kalisch, Tschannen, Lee, 2012	11 acute care hospitals with 124 units	3432 RNs and LPNs and 980 NAs	Cross sectional descriptive design	MISSCARE Survey, HHPD, Fall rate	HPPD negatively associated with falls. Higher missed care scores were associated with higher fall rates. Falls were sig related to the following elements of missed care: ambulation, each shift patient assessment, call light response, and toilet assistance. Focused reassessment and CMI were not associated with falls. Missed nursing care is a mediator of the relationship between HPPD and falls.		Only 11 hospitals studied in 2 states. Missed care based on perceptions of nursing staff
Kalisch, McLaughlin,	Inpatient in acute care hospital in	38 adults	Qualitative phenomenol	Semi-structured interview	Patients were interviewed to answer two questions: (1) What is the patient's		

Dabney, 2012	Midwest, consisted of seven different med/surg or ICUs		ogical	guide	ability to assess elements of nursing care? And (2) To what extent care was missed? Items of missed care that patients could report were categorized into three areas (fully reportable, partially reportable, and not reportable.) Fully reportable Frequently missed (mouth care, listening, and being kept informed) Sometimes missed (response to call lights, response to alarms, meal assistance, and pain medication and follow-up) Rarely missed (bathing) Partially reportable: Frequently missed (ambulation, discharge planning, and patient education) Sometimes missed (medication admin and		

					repositioning) Rarely missed (vital signs and hand washing) Not reportable: (1) patient assessment, (2) surveillance, (3) IV site care.		
Lawless, 2010	3 District Health Boards in New Zealand	1003 staff, 85% registered nurses, 10% healthcare assistants, 5% student nurses	Survey	The Safe Staffing Healthy Workplaces Survey – measures three key areas: 1. Staffing, workload, and quality of patient care, 2. Job satisfaction, and 3. DHB responsiveness to safe staffing healthy workplace agenda	1. Being able to make a difference is most valued aspect of job. 2. Workload/work intensity is the number one issue implicated in high rates of work related stress leave and intent to leave 3. Nurses responded to higher workload/intensity with increased work effort and decreased breaks 4. Nurses recognize unsafe staffing levels but have low levels or reporting. 5. The majority of nurses do not know what action has been taken following a report of a safe staffing action. 6. Nurses willing to be	Care omissions appear to be a universal phenomenon across settings and countries.	Low response rate 25% Did not list the 11 common patient care activities rationed

					redeployed to help in understaffed areas but only if they are adequately prepared and their home staff is not left short. 7. The majority of nurses believe their organizations are taking steps to address safe staffing. In regard to rationed care nurses reported 11 common patient care activities all were ranked as often or very often as being rationed. Nurses responded this by working an increased pace, missing breaks, staying past shift, work related stress leave, changing jobs, or leaving nursing.		
Rochefort, 2010	All nenonatial ICUs in Quebec	339 RNs	Cross-sectional correlational survey design	NWI-R, Neonatal Extent of Work Rationing Inventory (NEWRI), MBI	More favorable work environments were related to lower levels of nursing care rationing. Specifically rationing of parental teaching, support, infant comfort care, discharge planning and care coordination were 11% lower when nurse staffing		Self-reports of some measures. Newly developed instrument NEWRI, cross-sectional data do not allow for assessment of causal

					and resource adequacy were rated one point higher. There was a 5.7% and 7.7% reduction in rationing of life support, technologically-oriented nursing care, and patient surveillance between the best and worst ratings of nurse staffing and resource adequacy. A 4% per unit increase in nurse-physician relationships was related to a reduction rationing of life support and technologically-oriented nursing care, and patient surveillance. Rationing of care was an explanatory effect in the relationship between nurse-physician relationships and emotional exhaustion.		relationships.
Schubert, 2008	8 Swiss acute care hospitals, 118 medical, surgical,	1338 nurses, 779 patients	Multi-hospital cross-sectional survey	Basel extent of rationing of nursing care (BERNCA)	Nurses reported low levels of omitted care, but implicit rationing of nursing care was a significant predictor of all six patient outcomes		Cross-sectional design does not imply causality between rationed nursing care and patient

	and gyn units				studied. The six patient outcomes are: patient satisfaction, medication errors, patient falls, nosocomial infections, critical incidents, and pressure ulcers. Adequacy of nursing resources was on a sig predictor in adjusted models.		outcomes. Conducted in 1 country accounting for only 10% of hospital beds. Most variables assessed through nurse reports.
Sochalski, 2004	Pennsylvania	50% random sample of all RNs in PA, n = 85,000 only 9743 were used after exclusion/inclusion criteria.	Survey	Instruments measuring: quality of nursing care, patient workload, tasks undone, patient safety problems.	Quality of nursing care sig associated with number of patients the nurse cares for, rates of unfinished care for the patients, and frequency of patient safety problems.		

Appendix C

MISSCARE Survey

MISSED NURSING CARE (The MISSCARE Survey)
Beatrice J. Kalisch

1. **Name of the unit** you work on: _____

2. I spend **the majority of my working time** on this unit**:** _____ yes _____ no

3. **Highest education level:**
   1) _____ Grade school
   2) _____ High School Graduate (or GED)
   3) _____ Associate degree graduate
   4) _____ Bachelor's degree graduate
   5) _____ Graduate degree

4. **If you are a nurse, what is the highest degree:**
   1) _____ LPN Diploma
   2) _____ RN Diploma
   3) _____ Associate's degree in nursing (ADN)
   4) _____ Bachelor's degree in nursing (BSN)
   5) _____ Bachelor's degree **outside** of nursing
   6) _____ Master's degree (MSN) or higher in nursing
   7) _____ Master's degree or higher **outside** of nursing

5. **Gender:** _____ Female _____ Male

6. **Age:**
   1) _____ Under 25 years old (<25)
   2) _____ 25 to 34 years old (25-34)
   3) _____ 35 to 44 years old (35-44)
   4) _____ 45 to 54 years old (45-54)
   5) _____ 55 to 64 years old (55-64)
   6) _____ Over 65 years old (65+)

7. **Job Title/Role:**
   1) _____ Staff Nurse (RN)
   2) _____ Staff Nurse (LPN)
   3) _____ Nursing Assistant (e.g., nurse aides/tech)
   4) _____ Nurse manager, assistant manager (e.g. administrators on the unit)
   5) _____ Other [Please specify: _____]

Please turn over to page 2 ➔

8. Number of **hours usually worked per week** (check only one)
    1) _____ less than 30 hours per week
    2) _____ 30 hours or more per week

9. **Work hours** (check the one that is most descriptive of the hours you work)
    1) _____ Days (8 or 12 hour shift)
    2) _____ Evenings (8 or12 hour shift)
    3) _____ Nights (8 or 12 hour shift)
    4) _____ Rotates between days, nights or evenings

10. **Experience in your role:**
    1) _____ Up to 6 months
    2) _____ Greater than 6 months to 2 years
    3) _____ Greater than 2 years to 5 years
    4) _____ Greater than 5 year to 10 years
    5) _____ Greater than 10 years

11. **Experience** on your **current patient care unit:**
    1) _____ Up to 6 months
    2) _____ Greater than 6 months to 2 years
    3) _____ Greater than 2 years to 5 years
    4) _____ Greater than 5 year to 10 years
    5) _____ Greater than 10 years

12. **Experience** as a **Registered Nurse:**
    1) _____ Up to 6 months
    2) _____ Greater than 6 months to 2 years
    3) _____ Greater than 2 years to 5 years
    4) _____ Greater than 5 year to 10 years
    5) _____ Greater than 10 years

13. **Experience** with current **Electronic health record (EHR):**
    1) _____ Up to 6 months
    2) _____ Greater than 6 months to 2 years
    3) _____ Greater than 2 years to 5 years
    4) _____ Greater than 5 year to 10 years
    5) _____ Greater than 10 years

14. Which **shift** do you most often work?
    1) _____ 8 hour shift
    2) _____ 10 hour shift
    3) _____ 12 hour shift
    4) _____ 8 hour and 12 hour rotating shift
    5) _____ Other [Please specify: _____]

Please turn over to page 3 ➔

15. In the past 3 month, how many hours of **overtime** did you work?
    1) _____ None
    2) _____ 1-12 hours
    3) _____ More than 12 hours

16. In the past 3 months, how many days or shifts did you **miss work** due to illness, injury, extra rest etc. (exclusive of approved days off)?
    1) _____ None
    2) _____ 1 day or shift
    3) _____ 2-3 days or shifts
    4) _____ 4-6 days or shifts
    5) _____ over 6 days or shifts

17. Do you plan to **leave your current position?**
    1) _____ in the next 6 months
    2) _____ in the next year
    3) _____ no plans to leave

18. How often do you feel **the unit staffing is adequate?**
    1) _____ 100% of the time
    2) _____ 75% of the time
    3) _____ 50% of the time
    4) _____ 25% of the time
    5) _____ 0% of the time

19. **On the current or last shift** you worked, how many **patients** did you care for?

    _____

    19-a. how many **patient-admissions** did you have (i.e. includes transfers into the unit)? _____

    19-b. how many **patient-discharges** did you have (i.e. includes transfers out of the unit)? _____

Please turn over to page 4 ➔

Please check one **response for each question.**

	Very satisfied	Satisfied	Neutral	Dissatisfied	Very dissatisfied
20. **How satisfied** are you in your **current position**?					
21. Independent of your current job, **how satisfied** are you with **being a nurse or a nurse assistant?**					
22. **How satisfied** are you with **the level of teamwork on this unit?**					

Please **turn over** *to page 5* ➔

Section A — Missed Nursing Care

Nurses frequently encounter multiple demands on their time, requiring them to reset priorities, and not accomplish all the care needed by their patients. To the best of your knowledge, **how frequently** are the following elements of **nursing care MISSED by the nursing staff (including you) on your unit?** ***Check only one box for each item.***

	Always missed	**Frequently** missed	**Occasionally** missed	**Rarely** missed	**Never** missed
1) Ambulation three times per day or as ordered					
2) Turning patient every 2 hours					
3) Feeding patient when the food is still warm					
4) Setting up meals for patient who feeds themselves					
5) Medications administered within 30 minutes before or after scheduled time					
6) Vital signs assessed as ordered					
7) Monitoring intake/output					
8) Full documentation of all necessary data					
9) Patient teaching about illness, tests, and diagnostic studies					
10) Emotional support to patient and/or family					
11) Patient bathing/skin care					
12) Mouth care					
13) Hand washing					
14) Patient discharge planning and teaching					
15) Bedside glucose monitoring as ordered					
16) Patient assessments performed each shift					

Please ***turn over*** *to page 6* ➔

	Always missed	**Frequently** missed	**Occasionally** missed	**Rarely** missed	**Never** missed
17) Focused reassessments according to patient condition					
18) IV/central line site care and assessments according to hospital policy					
19) Response to call light is initiated within 5 minutes					
20) PRN medication requests acted on within 15 minutes					
21) Assess effectiveness of medications					
22) Attend interdisciplinary care conferences whenever held					
23) Assist with toileting needs within 5 minutes of request					
24) Skin/Wound care					

THANK YOU FOR YOUR PARTICIPATION!

Appendix D

Impact of Healthcare Information Technology (I-HIT) Scale

Impact of Healthcare Information Technology (I-HIT) Scale

General advantages of HIT	1 Strongly Disagree	2 Moderately Disagree	3 Slightly Disagree	4 Slightly Agree	5 Moderately Agree	6 Strongly Agree	NA
1. HIT applications/tools have decreased the time I need for end of shift report.							
2. HIT applications have decreased the need for direct communication around writing patient orders.							
3. HIT provides better information to prepare me for my assigned patients each day.							
4. HIT facilitates practice efficiency.							
5. HIT allows for patient/family participation in care							
6. The ability of interdisciplinary team members to access information electronically has reduced their need to communicate directly with each other face-to-face or via phone.							
7. The ability of nurses to access information electronically has improved their ability to independently make decisions.							
8. HIT applications available at my facility improve my ability to assume care for patients transferring into my unit.							
9. Work lists generated from HIT tools support efficient patient care.							
Workflow Implications of HIT	1 Strongly Disagree	2 Moderately Disagree	3 Slightly Disagree	4 Slightly Agree	5 Moderately Agree	6 Strongly Agree	NA
1. The ways in which data/ information are displayed using HIT improves access to data.							
2. HIT depersonalizes care.							
3. The HIT applications available at my site help me to process data and therefore improve access to information necessary to provide safe patient care.							
4. The availability of electronic interdisciplinary documentation has improved the capacity of clinicians to work together.							
5. HIT applications/tools support the nursing process.							
6. The ways in which data/ information are displayed using HIT reduces redundancy of care.							
7. The ways in which data/ information are displayed using HIT facilitates interdisciplinary care planning.							
8. HIT applications/tools facilitate interdisciplinary treatment planning.							
Information Tools to Support Communication Tasks	1 Strongly Disagree	2 Moderately Disagree	3 Slightly Disagree	4 Slightly Agree	5 Moderately Agree	6 Strongly Agree	NA
1. My site is utilizing HIT strategies to optimize interdisciplinary communication (e.g. clinical messaging, Vocera or similar wireless voice communication system, text paging).							
2. Available HIT applications/tools facilitate the process of patient tracking.							
3. I have access to HIT applications/tools that support interdisciplinary communication when I need them.							

4.	Available HIT tools support both patient care and administrative processes.							
5.	HIT facilitates ID communication that is patient centered.							
6.	The availability of information afforded by HIT at my site helps nurses collaborate at a higher level with interdisciplinary colleagues than was possible with paper systems.							
7.	I know how to access the HIT applications/tools available in the electronic medical record system.							
	Information Tools to Support Information Tasks	1 Strongly Disagree	2 Moderately Disagree	3 Slightly Disagree	4 Slightly Agree	5 Moderately Agree	6 Strongly Agree	NA
1.	I find the acknowledgement features of current HIT applications/tools provide adequate assurance that my interdisciplinary colleagues have received the communications that I send							
2.	I find the acknowledgement features of current HIT applications/tools provide adequate assurance that interdisciplinary colleagues have acted upon information that I send.							
3.	HIT promotes 2-way communication between clinicians about patient status.							
4.	Communication of critical events to interdisciplinary colleagues can be done effectively using HIT.							
5.	HIT applications/tools help me to be problem-focused in my communications.							

Appendix E

Nursing Care Reminders Survey

Nursing Care Reminders Survey

Directions:

1. Please rate each of the following statements regarding nursing reminders by clearly marking the choice that corresponds with your rating.

Example:

Always	Frequently	Occasionally	Rarely	Never
	X			

2. Please be honest of your true ratings. This rating will not be shared with your peers and will not be used to determine your grade in the course.

3. Definitions:

    a. EHR - An electronic database and accompanying graphical user interface which enables clinicians to document and retrieve patient care information that aids the clinician in clinical reasoning to make informed clinical decisions. This would include but is not limited to computerized physician order entry (CPOE), order and result processing and communication, patient scheduling, clinical reminders, task or work lists, and clinical documentation.

    b. Nursing reminder – an electronic list, prompt, or cue of tasks or procedures that need to be completed by either the nurse or nursing attendant during their shift.

    c. Nursing care activity – any patient care delivered by a nurse.

1. How frequently do you utilize the following types of nursing care reminders to assist you in completing nursing care activities?

Type of Reminder	Always	Frequently	Occasionally	Rarely	Never	N/A
1.1 A paper list of reminders based on what is in the EHR						
1.2 A print out of a list of care activities that serve as a reminder						
1.3 Electronic nursing care orders in the EHR that serve as a reminder						
1.4 List of nursing care activities in the plan of care that serve as a reminder						
1.5 Electronic list of reminders in EHR (i.e., task list, documentation check list, documentation form, work queue, work list)						
1.6 Electronic list of reminders not in EHR						
1.7 Computerized provider order entry (CPOE) list that serve as a reminder						
1.8 Electronic documentation in the EHR that serve as a reminder						
1.9 Alert or reminder message pop-ups in the EHR						
1.10 Text page reminders						
Other (please list):						

2. How frequently do you utilize nursing care reminders to assist you in completing nursing care activities?

Always	Frequently	Occasionally	Rarely	Never

3. How helpful do you find the electronic nursing care reminders?				
Always	**Frequently**	**Occasionally**	**Rarely**	**Never**

Appendix F

Standardized Form to Collect Unit RNHPPD and CMI

Standardized Form to Collect Unit RNHPPD and CMI

Unit	RNHPPD	CMI

Appendix G

Standardized Email Sent to Registered Nurses

Standardized Email Sent to Registered Nurses

Dear Registered Nurse,

My name is Ronald Piscotty and I am a PhD in Nursing Student at the University of Michigan School of Nursing, Ann Arbor. I am currently conducting my dissertation research and would graciously appreciate your participation in my study.

The study is entitled: The Relationship Between Electronic Nursing Care Reminders and Missed Nursing Care. There are three short surveys that will need to be completed online using the web link listed below. The surveys should take no more than 20 minutes to complete and you can save your survey and return at a later time to complete. The surveys will ask about your perceptions of the impact of healthcare information technology on your practice and missed nursing care.

The survey will be open from _____ to _____. I will send periodic reminders each week to remind you to complete the survey. A unit incentive will be offered to the units that have 60% or higher of their nurses completing the survey. The incentive will be a Large Edible Arrangement delivered to each shift.

No identifying information will be collected; the data will kept anonymous and cannot be linked back to the person completing the survey.

By completing the survey you give your consent to participate in the study. If you do not wish to participate in this study, please do not complete the survey.

Should you have any questions about participating in the survey, please feel free to contact me at: piscotty@umich.edu or by phone at: 586-588-0271.

Survey Link: PLEASE CLICK HERE TO BEGIN SURVEY

Sincerely,
Ronald Piscotty, MSN, RN-BC
PhD in Nursing Candidate
University of Michigan
School of Nursing
piscotty@umich.edu
586-588-0271

Appendix H

Standardized Email Sent to Nursing Managers

Standardized Email Sent to Nursing Managers

Dear (Nurse Manager),

My name is Ronald Piscotty and I am a PhD in Nursing Student at the University of Michigan School of Nursing, Ann Arbor. I am currently conducting my dissertation research and would graciously appreciate your units Registered Nurses participation in my study.

The study is entitled: The Relationship Between Electronic Nursing Care Reminders and Missed Nursing Care. There are three short surveys that will need to be completed online using an online web link. The surveys should take no more than 20 minutes to complete and can be saved and returned to a later time to complete. The surveys will ask about RN perceptions of the impact of healthcare information technology on their practice and missed nursing care.

The survey will be open from _____ to _____. I will send periodic reminders each week to remind the RNs to complete the survey. I would appreciate if you could remind your RN's to complete the survey each week as well. I will have flyers available to post on the unit as reminders as well. I would ask that you or the appropriate designee place the flyers in an area of high visibility by the RNs. A unit incentive will be offered to the units that have 60% or higher of their nurses complete the survey. The incentive will be a Large Edible Arrangement delivered to each shift.

No identifying information will be collected; the data will kept anonymous and cannot be linked back to the person completing the survey.

By completing the survey the RNs consent to participate in the study. If they do not wish to participate in this study, they do not need to complete the survey.

Should you have any questions about study or survey, please feel free to contact me at: piscotty@umich.edu or by phone at: 586-588-0271.

Sincerely,
Ronald Piscotty, MSN, RN-BC
PhD in Nursing Candidate
University of Michigan
School of Nursing
piscotty@umich.edu
586-588-0271

Appendix I

Standardized Flyer to Participate in Study

Standardized Flyer to Participate in Study

UNIVERSITY OF MICHIGAN

Is There a Relationship Between Electronic Nursing Care Reminders and Missed Nursing Care?

My name is Ronald Piscotty and I am a PhD in Nursing Student at the University of Michigan School of Nursing, Ann Arbor. I am currently conducting my dissertation research and would graciously appreciate your participation in my study. An email with directions has been sent to your Beaumont email address.

The study is entitled: **The Relationship Between Electronic Nursing Care Reminders and Missed Nursing Care.** There are three short surveys that will need to be completed online using the web link listed below. The surveys should take no more than 20 minutes to complete and you can save your survey and return at a later time to complete. The surveys will ask about your perceptions of the impact of healthcare information technology on your practice and missed nursing care.

The survey will be open from _____ to _____.

A unit incentive will be offered to the units that have 60% or higher of their nurses completing the survey. The incentive will be a Large Edible Arrangement delivered to each shift.

No identifying information will be collected; the data will kept anonymous and cannot be linked back to the person completing the survey.

By completing the survey you give your consent to participate in the study. If you do not wish to participate in this study, please do not complete the survey.

Should you have any questions about participating in the survey, please feel free to contact me at: piscotty@umich.edu or by phone at: 586-588-0271.

Sincerely,
Ronald Piscotty, MSN, RN-BC
PhD in Nursing Candidate
University of Michigan
School of Nursing
piscotty@umich.edu
586-588-0271

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