INFORMATION TECHNOLOGY USE IN PREDICTION OF RAPID RESPONSE EPISODES, PRESSURE ULCER STATUS, AND 30 DAY READMISSION

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Doctor of Philosophy

By

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the dissertation entitled

INFORMATION TECHNOLOGY USE IN PREDICTION OF RAPID RESPONSE
EPISODES, PRESSURE ULCER STATUS, AND 30 DAY READINGMISSION

Presented by Marilyn M. Shepherd, a candidate for the degree of doctor of
philosophy and hereby certify that, in their opinion, it is worthy of acceptance.

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DEDICATIONS

My parents who inspired me to reach as far as I could.

My loving husband, Michael, for supporting my decision in the beginning of my journey, the strength in the middle, and the ability to breathe on completion of my doctoral journey.
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<tr>
<td>BPM</td>
<td>Beats per minute</td>
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<tr>
<td>BRAS</td>
<td>Braden Risk Assessment Score</td>
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<td>BUN</td>
<td>Blood Urine Nitrogen</td>
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<tr>
<td>CI</td>
<td>Confidence Interval</td>
</tr>
<tr>
<td>CMS</td>
<td>Centers for Medicare and Medicaid Services</td>
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<tr>
<td>CMT</td>
<td>Certified Medical Technician</td>
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<tr>
<td>CNA</td>
<td>Certified Nurse Assistant</td>
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<tr>
<td>DON</td>
<td>Director of Nursing</td>
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<tr>
<td>EHR</td>
<td>Electronic Health Record</td>
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<tr>
<td>HAPU</td>
<td>Hospital acquired pressure ulcer</td>
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<td>HGB</td>
<td>Hemoglobin</td>
</tr>
<tr>
<td>HIM</td>
<td>Health Information Management</td>
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<tr>
<td>ICD-9</td>
<td>International Classification of Diseases Version 9</td>
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<tr>
<td>IT</td>
<td>Information Technology</td>
</tr>
<tr>
<td>ITS</td>
<td>Information Technology Sophistication</td>
</tr>
<tr>
<td>LPN</td>
<td>Licensed Practical Nurse</td>
</tr>
<tr>
<td>LTAC</td>
<td>Long Term Acute Care</td>
</tr>
<tr>
<td>Abbreviation</td>
<td>Full Form</td>
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<td>--------------</td>
<td>-----------</td>
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<tr>
<td>MSD Coordinator</td>
<td>Minimal Data Set Coordinator</td>
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<tr>
<td>MEWS</td>
<td>Modified Early Warning System</td>
</tr>
<tr>
<td>MIN</td>
<td>Minute</td>
</tr>
<tr>
<td>NPUAP</td>
<td>National Pressure Ulcer Advisory Panel</td>
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<tr>
<td>PU</td>
<td>Pressure Ulcer</td>
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<tr>
<td>RESP</td>
<td>Respiratory</td>
</tr>
<tr>
<td>RI</td>
<td>Rothman Index</td>
</tr>
<tr>
<td>RMT</td>
<td>Restorative Medical Assistant Technician</td>
</tr>
<tr>
<td>RN</td>
<td>Register Nurse</td>
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<tr>
<td>SD</td>
<td>Standard Deviation</td>
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<tr>
<td>VAS</td>
<td>Visual Analogue Pain Scale</td>
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<td>WBC</td>
<td>White Blood Count</td>
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CHAPTER ONE: INTRODUCTION

Health care safety and quality care remain high priorities in U.S. hospitals, which have been motivated in part by the Institute of Medicine’s landmark report *To Err is Human: Building a Safer Health System* (Kohn, Corrigan, & Donaldson, 2000). Despite a concerted nationwide focus on quality and safety initiatives for nearly two decades, more than 400,000 preventable patient deaths occur annually in U.S. hospitals (James, 2013). Furthermore, over 1 million medical errors occur in U.S. hospitals each year (David, Gunnarsson, Waters, Horblyuk, & Kaplan, 2013) with an estimated annual cost as high as 17.1 billion dollars (Van Den Bos, Rustagi, Gray, Halford, Ziemkiewicz, & Shreve, 2011). Medical errors have been reported as the third leading cause of death in the U.S. (Makary & Daniel, 2016). These data suggest that medical errors occur much more frequently than previously documented, and not only cause serious patient harm but also significantly increase healthcare costs (Weigart, Wilson, & Harrison, 2000).

In the last decade, the increased healthcare costs associated with preventable errors and serious hospital acquired conditions has been shifted away from third party payers to hospitals. In 2008, the Centers for Medicare and Medicaid Services (CMS) announced that they would no longer pay for the cost to treat selected hospital-acquired conditions (Averill, Hughes, Goldfield, & McCullough, 2009). The CMS list of non-reimbursable serious hospital acquired conditions has evolved over time, but examples include catheter associated urinary tract infections, deep vein thrombosis/pulmonary emboli, falls and trauma, stage 3 and 4 pressure ulcers, and select surgical site infections (McNair & Luft, 2012). The passage of the Patient Protection and Affordable Care Act provided
opportunities, challenges, and incentives for healthcare related to preventable errors and serious hospital acquired conditions in the hospital. The challenges fostered changes in practice, focusing on quality care through the use of information technology. The negative outcomes for hospitals were the loss or limited reimbursement monies from CMS for preventable errors and serious hospital acquired conditions, while positive incentives were added to induce hospitals to reduce readmissions and hospital-acquired infections (Kocher, Ezekiel, & DeParle, 2010). Collectively, this series of events has culminated in hospitals being fiscally responsible for the majority of the costs of healthcare associated errors (David et al., 2013). Additionally, hospital complications and patient safety indicators are now available to consumers on the Internet (Agency for Healthcare Quality and Research, 2007). As a result, hospitals have become increasingly motivated to prevent adverse events and readmissions.

**Hospital Acquired Pressure Ulcers (HAPU)**

Hospital acquired pressure ulcers (HAPU), specifically stage 3 and 4, are a serious reportable adverse event and their prevention is considered an important indicator of quality (Bergquist-Beringer, Dong, He, & Dunton, 2013; Bergquist-Beringer, Gajewski, & Davidson, 2012; National Quality Forum, 2011). Despite the publication of evidence-based, pressure ulcer prevention guidelines beginning in 1996 (Agency for Health Care Policy and Research, 1996), HAPU continue to be a problem in hospitals (David et al., 2013; Goldberg, 2012; Lyder, Wang, Metersky, Curry, Kilman, Verzier, & Hunt, 2012; Russo, Steiner, & Spector, 2008; Vangilder, Amlung, Harrison, & Meyer, 2009). For example, one single center study examining congruence between measures of adverse events found that approximately 43% of provider-reported adverse events were
related to pressure ulcers and other skin integrity issues (Naessens, Campbell, Huddleston, Berg, Lafante, Williams, & Culbertson, 2009). Moreover, using the Premier hospital claims database from 2008 and 2009, David and colleagues (2013) found that HAPU were the most common adverse event in both years impacting an estimated 500,000 patients per year.

HAPU are associated with increased healthcare costs and utilization as well as mortality. Reported costs of HAPU per patient have ranged from $500 to $40,000 (Baldelli & Paciella, 2008). When extrapolated to the entire U.S. population, HAPU costs are estimated to be between $478,501,236 and $500,801,536 (David et al., 2013) per year! Regarding healthcare utilization, patients with a HAPU have a hospital risk-adjusted mean length of stay 6.4 days longer \((p<.001)\) than patients without a HAPU (Lyder et al., 2012). Additionally, patients with a HAPU are more likely to be discharged to a long-term care facility than patients without a HAPU (Russo et al., 2008). Moreover, individuals with HAPU have higher in-hospital mortality as well as a higher mortality within 30 days of discharge than patients without a HAPU (Lyder et al., 2012). Specifically, it is estimated that 60,000 U.S. patients die each year due to HAPU related complications (Lyder et al., 2012). Collectively, these data document that HAPU are important and costly adverse events; and additional strategies are needed to improve HAPU prevention practices in hospitals (Bergquist-Beringer et al., 2013).

**Re-admission within 30 Days of Hospital Discharge**

Hospital readmissions are estimated to cost the CMS approximately $26 billion/year (Boozary, Manchin, & Wicker, 2015) and are associated with poor outcomes. Beginning in 2009, public reporting of 30-day hospital readmission rates for select
conditions was required by the CMS. Public reporting in and of itself did not, however, significantly decrease the 30-day readmission rates (DeVore, Hammill, Hardy, Eapen, Peterson, & Hernandez, 2016). Subsequently, in 2012, as part of the Patient Protection and Affordable Care Act, the CMS instituted the Hospital Readmissions Reduction Program. The Hospital Readmissions Reduction Program was designed to decrease hospital readmissions of Medicare recipients by reducing payments to hospitals with excess readmissions (Joynt & Jha, 2013). The Hospital Readmissions Reduction Program appears to be having a positive impact as evidenced by decreased hospital readmission rates for both targeted and non-targeted conditions between 2007 and 2015 (Zuckman, Sheingold, Oray, Ruhter, & Epstein, 2016).

Readmission to the hospital within 30 days of discharge also is an outcome of interest in the HAPU patient population. Older adults are at higher risk for adverse events, such as HAPUs, than the general population due to advanced age, less than optimal nutrition, and chronic health conditions (Garcia, 2012; Thomas & Compton, 2013). In a recent analysis of the national Medicare Patient Safety Monitory System database, Lyder and colleagues (2012) found that patients who developed a HAPU during their hospitalization were more likely to be readmitted within 30 days of discharge (adjusted odds ratio = 1.33, 95% CI = [1.23, 1.45]) than patients who did not develop a HAPU. Thus, decreasing HAPU is particularly important as it may also assist hospitals to decrease 30-day readmission rates.

**Health Information Technology and Healthcare Safety and Quality**

The lack of patient specific information available to all health care providers has been identified as a contributing factor to unsafe patient care. A number of concerned
parties (e.g. Agency for Healthcare Research and Quality, healthcare providers, Institute Of Medicine, The Leapfrog Group) have publicly recommended the use of health information technology to improve healthcare quality and safety (Zhang, Sebledge, Wan, Unruh, Agiro, Miao, 2013). For example, the Patient Protection and Affordable Care Act and the American Recovery and Reinvestment Act specifically include health information technology provisions to help facilitate the incorporation of guidelines, alerts, and clinical decision support systems into electronic health records (Kocher et al., 2010).

Some hospitals utilize an early warning system to assist with early identification and management of deteriorating patients on medical surgical units (Mathukia, Fan, Vadak, Biege, & Krishnamurthy, 2015; Wu Zhu, Gong, Tian, Liu, …Shi, 2015). The benefit of using an early warning system integrated into the electronic health record is that it can monitor for changes over time, alert health care providers to changes in a patient’s condition, and help prevent potential untoward events such as cardiopulmonary arrest (M. Rothman, Rothman, & Beals, 2013a). Many early warning systems are considered track-and-trigger systems, meaning that once a patient is identified as being at high risk, an action is triggered such as deployment of a Rapid Response Team (Mathukia et al., 2015; Petersen, Mackel, Antonsen, & Rasmussen, 2014; Suarez, Menendez, Alonso, Castano, Alonso, Vazquez, 2014; Winters, Weaver, Pfoh, Yang, Pham, & Dy, 2013). Rapid response teams were initiated by hospitals as a safety strategy to provide active surveillance and early treatment of life-limiting and potentially preventable adverse events (Amaral, McDonald, Colburn, Wei, Shojania, Fowler…Adhikari, 2015; Winters, Pham, & Pronovost, 2006). A recent meta-analysis
suggests response teams significantly reduced non-ICU cardiorespiratory arrests in adults (Winters et al., 2013). Since risk factors associated with HAPU include hypotension and hypoxemia (Goodell & Moskovitz, 2013; Man & Au-Yeung, 2013), rapid response episodes may be associated with HAPUs.

One recent study conducted in China utilized an early warning system to identify the risk of nursing sensitive outcomes such as falls, medication errors, pressure ulcers and unplanned extubation. Wu and colleagues (2015) used a three-color traffic light vigilance system integrated into the hospital’s health information system and personal digital assistant. Specific interventions were aligned based on risk. The study reported the qualified rate of prevention of pressure ulcer increased from 90.5% in 2009 to 99.77% in 2013 (Wu et al., 2015). Early identification of subtle changes allows intervention time to resolve potentially devastating hospital-acquired conditions. The incidence of HAPUs has been documented to be higher in critically ill patients compared to medical-surgical patients (Stechmiller, Cowan, Whitney, Phillips, Aslamn, Barbul…Stotts, 2008; Vangilder et, al., 2009). If it were known that deteriorating patient conditions in adult medical-surgical patients, such as those identified by rapid response team were associated with the development of HAPU, then nurses could modify their pressure ulcer intervention strategies to help prevent adverse patient outcomes.

**Summary**

In the last two decades, there has been an increased focus on quality and safety in hospitals. The Patient Protection and Affordable Care Act tied reimbursement and information technology advancements to safe quality care. Pressure ulcer occurrence is associated with increased morbidity, length of stay, readmission within 30 days of
discharge, and mortality. Despite widespread utilization of the valid and reliable Braden Risk Assessment Scale (BRAS) in a variety of healthcare settings, pressure ulcers continue to persist in the hospital environment as present on admission or as HAPU. Use of an early warning system, such as the Rothman Index (RI), may assist in early detection of subtle changes to guide nurses’ interventions. The availability of accurate, point of care clinical data may help improve the quality of pressure ulcer prevention management in hospitalized adults. No such system had been developed for the general medical-surgical hospitalized patients at the time of the study.

This purpose of this dissertation project was to investigate (a) pressure ulcer risk assessment; (b) how pressure ulcer risk and prevention were communicated in acute and long-term care settings; and (c) how health information technology may assist in identifying (1) pressure ulcer risk at discharge, (2) pressure ulcer status at discharge, (3) rapid response episodes, and (4) unplanned hospital readmission within 30 days. As part of this dissertation, two manuscripts are presented. One published manuscript, “Analysis of Qualitative Interviews about the Impact of Information Technology on Pressure Ulcer Prevention Programs: Implications for the Wound Ostomy Continence Nurse” (Shepherd, Wipke-Tevis, & Alexander, 2015), was developed with data analyzed as part of the advanced research practicum Marilyn Shepherd completed with Dr. Greg Alexander. The second manuscript, “Rothman Index as a Predictor of Rapid Response Episode Occurrence, Pressure Ulcer Status at Discharge and Hospital Readmission in Adult Medical-Surgical Patients,” was developed with data resulting from the original and significant investigation completed by Marilyn Shepherd. The specific aims and research questions follow below.
Specific Aims

Specific Aim 1: To examine pressure ulcer prevalence, BRAS scores, Rothman (RI) scores, and rapid response episodes in adult medical-surgical patients at discharge, using data from the electronic health record.

Research Question 1a: Upon discharge, what is the overall prevalence of pressure ulcers at discharge, regardless of ulcer severity, and the prevalence of the most severe category of pressure ulcers at discharge, classified as a Stage 1, Stage 2, Stage 3 or Stage 4, in adult hospitalized medical-surgical patients in a rural Midwestern hospital?

Research Question 1b: In adult medical-surgical patients, is there a difference between the average BRAS score for individuals with or without a pressure ulcer at discharge, regardless of ulcer severity?

Research Question 1c: In adult medical-surgical patients, is there a difference between the average RI score for individuals with and without a pressure ulcer at discharge, regardless of ulcer severity?

Research Question 1d: In adult medical-surgical patients, is there an association between experiencing a rapid response episode any time during the hospitalization and the presence or absence of a pressure ulcer at discharge, regardless of ulcer severity?

Research Question 1e: Is there an association between the BRAS score and the RI score upon discharge in adult medical-surgical patients?
**Specific Aim 2:** To compare BRAS scores, rapid response episodes, RI scores, nursing staff reviews of the RI scores and hospital readmission within 30 days in adult medical-surgical patients discharged with or without a pressure ulcer, regardless of ulcer severity using data from the electronic health record.

**Research Question 2a:** Is there a difference between the 30-day hospital re-admission rates for adult medical-surgical patients discharged with or without a pressure ulcer, regardless of ulcer severity?

**Research Question 2b:** Of the patients readmitted within 30 days of hospital discharge, is there an association between BRAS risk categories (Low Risk, Moderate Risk, Highest Risk), and patients discharged with or without a pressure ulcer, regardless of ulcer severity.

**Research Question 2c:** Of the patients readmitted within 30 days of hospital discharge, is there an association between the RI risk categories (Low Risk, Moderate Risk, Highest Risk) and patients with or without a pressure ulcer, regardless of ulcer severity?

**Research Question 2d:** Is there a relationship between experiencing a rapid response episode during the hospitalization and hospital readmission within 30 days in adult medical-surgical patients discharged with or without a pressure ulcer, regardless of ulcer severity?

**Research Question 2e:** Of the patients readmitted within 30 days of hospital discharge, is there a difference in average number of nurse RI reviews between patients discharged with or without a pressure ulcer, regardless of ulcer severity?
CHAPTER TWO:
ANALYSIS OF QUALITATIVE INTERVIEWS ABOUT THE IMPACT OF INFORMATION TECHNOLOGY ON PRESSURE ULCER PREVENTION PROGRAMS: IMPLICATIONS FOR WOUND, OSTOMY, AND CONTINENCE NURSE


Permission letter from Copyright Clearance Center can be found in Appendix A.
Abstract

PURPOSE: The purpose of this study was to compare pressure ulcer prevention programs in two long-term care (LTC) facilities with diverse Information Technology Sophistication (ITS), one with high sophistication and one with low sophistication and to identify the implications for the Wound, Ostomy, and Continence (WOC) Nurse.

DESIGN: Secondary analysis of narrative data obtained from a mixed-method study.

SUBJECTS AND SETTING: The study setting was two LTC facilities in the Midwestern United States. The sample comprised 39 staff from two facilities, including 26 from a high-ITS facility and 13 from the low-ITS facility. Respondents included certified nurse assistants, certified medical technicians, restorative medical technicians, social workers, RNs, licensed practical nurses, information technology staff, administrators and directors.

METHODS: The study is a secondary analysis of interviews regarding communication and education strategies in two LTC agencies. This analysis focused on focus group interviews, which included both direct and nondirect care providers.

RESULTS: Eight themes (codes) were identified in the analysis. Three themes are presented individually with exemplars of communication and education strategies. The analysis revealed specific differences between the high-ITS and low ITS-facilities in regard to education and communication involving pressure ulcer prevention. These differences have direct implications for WOC nurses consulting in the LTC settings.

CONCLUSIONS: Findings from this study suggest that effective strategies for staff education and communication regarding PU prevention differ based on the level of ITS
within a given facility. Specific strategies for education and communication are suggested for agencies with high ITS and agencies with low ITS.

KEY WORDS: Information Technology Sophistication, Long-term care, Pressure ulcer prevention, Qualitative interviews.
Because of the significant morbidity, mortality, and health care costs associated with pressure ulcers (PUs), and widespread consensus that the majority of these wounds are preventable, the Center for Medicare and Medicaid Services has curtailed reimbursement for facility-acquired Stage 3 and Stage 4 pressure ulcers (Centers for Medicare and Medicaid Services (CMS), HHS, 2011). Thus, PU prevention is now a fiscal and clinical priority for health care agencies in the United States.

Pressure ulcers are particular problems in the LTC setting, and patients with PUs are more likely to be admitted to an LTC facility (Pieper, 2012; Russo, Steiner, & Spector, 2008). In 2004, the National Nursing Home survey estimated the prevalence of PUs among LTC residents as 11%, the most common being stage II (Park-Lee & Caffrey, 2009). Horn and colleagues (Horn, Bender, Ferguson, Smout, Bergstrom, Taler…Voss, 2004) found that 29% of LTC residents developed a new PU within 12 weeks of admission. National Pressure Ulcer Advisory Panel data published in 2012 documented incidence rates ranging from 3.6% to 59% and prevalence rates ranging from 8.5% to 32.2%, depending upon whether stage I PUs were included in the study (National Pressure Ulcer Panel Advisory Panel, 2012). These data suggest that, despite the existence of evidenced-based prevention guidelines and quality indicators, PUs continue to be a problem in the LTC setting.

The elderly are especially at risk for PU development due to multiple factors, including poor nutritional status, frailty and impaired mobility (Spirduso, Francis, & MacRae, 2005). Factors that add to PU risk specific to the LTC setting include staffing issues, challenges related to nutritional and fluid management, comorbid conditions, polypharmacy, and delayed or incomplete incorporation of evidenced-based PU
prevention protocols (Horn et al., 2004). State-of-the-science education and ongoing communication between staff members are vital to effective implementation of PU prevention and management interventions in this vulnerable population. One strategy that has been suggested to help improve PU prevention and management is the use of information technology (IT) (Alexander, Steege, Pasupathy, & Wise, 2013; American Health Information Management Association et al., 2015; Fossum, Alexander, Ehnfors, & Ehrenberg, 2011; Fossum, Ehnfors, Svensson, Hansen, & Ehrenberg, 2013; & Manard et al., 2015). For example, IT can assist the staff to gather valid and reliable data in a timely manner to support clinical decision making, and the availability of accurate, point-of-care clinical data may help improve the quality of PU prevention in individual residents (Rantz, Hicks, Petroski, Madsen, Alexander, Galambos…Greenwald, 2010). However, there are limited data on the use of IT in prevention of PU in the LTC setting. Therefore, the purpose of this study was to explore education and communication strategies for PU prevention in LTC facilities with diverse ITS (Information Technology Sophistication).

**Methods**

This study was a secondary analysis of existing narrative data obtained from a mixed methods study that investigated work flow and communication strategies among certified nursing assistants (CNA) in two diverse LTC facilities in a Midwestern state (Alexander et al., 2013). The research methods of the primary study included structured observations, communication network analysis, qualitative focus groups of LTC staff, and quantitative analysis of PU prevention communication strategies. A detailed description of the focus group methodology may be found in the original study.
(Alexander et al., 2013). After obtaining approval from the Health Sciences Institutional Review Board, the current study focused specifically on the qualitative narrative analysis of the focus group data including a comparison of direct and non-direct care provider perspectives.

**Data Analysis**

For this secondary analysis, original digital recordings of the focus groups were transcribed into a Word document for the two facilities per personnel category and shift worked. The transcribed Word document was then entered into NVIVO 9, a software package for qualitative analysis (NVIVO, QSR International, 2011). Data in the form of words, phrases and sentences were coded and assigned categories that represented themes (nodes) about the facilities’ communication strategies relevant to PU prevention. Themes (nodes) identified the specific communication strategies used by the two facilities participating in the study and were used to capture factors and processes unique to each facility in regard to communication related to PU prevention. Using the word similarity analysis feature in NVIVO, similar words were clustered by nodes and plotted. Links among the nodes and sub-nodes demonstrated interrelationships between communication strategies related to PU prevention in the high-ITS facility and the low-ITS facility. Exemplars were used to bring forth the richness of the communication.

**Results**

The sample was recruited from two LTC facilities located in urban settings in the Midwestern United States; the bed size of the facilities was 60 and 78. One LTC facility was for-profit and the other was not-for-profit. One was found to have high-ITS facility and the other had low-ITS facility. Risk-adjusted PU quality measures for high-risk and
low-risk residents were similar for the high-risk facility (3% and 0%, respectively) and the low-ITS (3% and 0%, respectively) (Alexander et al., 2013). A total of 39 personnel participated in the focus groups, consisting of 26 staff members from the high-ITS facility and 13 from the low-ITS facility. Participants included CNAs, certified medical technicians, restorative medical technicians, social workers, RNs, licensed practical nurses, IT staff, administrators, and directors. Participants worked on the day, evening, and night shifts. Table 1 depicts the facility, shift, type of personnel, and years of service of the sample.

Eight themes emerged related to communication strategies for the prevention of PUs: bedside alert, difficulty with communication, education opportunities, electronic communication/documentation, e-mail, PU prevention strategies, report sheets, and verbal reports. Differences between the two agencies in terms of communication related to PU prevention are outlined in Table 2. To evaluate differences in communication patterns between the low- and high ITS facilities, we focus on three major themes: (1) education opportunities, (2) electronic communication and documentation (information access), and (3) PU prevention strategies.

Theme 1: Educational Opportunities

Although PU prevention education was provided to staff at both facilities, participants reported distinct differences in its delivery. In the low-ITS facility, educational offerings were accessed through Silver Chair (Silver Chair Information Systems, Charlottesville, Virginia), a computer-based education program used in LTC facilities. One direct care provider stated, “Not much is offered, all staff has 1-2 tests every month on various topics including skin issues, pressure sores and other various
topics. All staff do tests on Silver Chair. One computer is available.” The one computer was located in a multipurpose room to allow care providers access. The room was also used as a beauty salon, which limited access for computer-based learning. The combination of limited access and the limited computer availability was considered a barrier by direct care providers.

In contrast, participants at the high-ITS facility stated that they considered education to be a routine job-related responsibility. Skin care information was shared during orientation of new providers, to current direct care providers via e-mails, and in skin care meetings. For example, when the new picture alerts were implemented, reminder pictures were placed at the time clocks to highlight the new skin care alert protocols. One direct health care provider reported, “When the program was started with the various pictures, the picture image was imbedded in e-mail for them to see it.” Another direct care provider shared, “Skin Care team will occasionally have a presentation and inform staff on various issues: things they’ve noticed or what they’ve done, etc.” Staff meetings provided additional education, as reflected by another focus participant: “All staff meetings every month give a run-down of how the month is going. We demonstrated positioning techniques recently in a meeting. Nurse’s meetings [occur] every other month with all shifts. If there are any nursing issues, that’s discussed at the Nurse’s meeting.”

The high-ITS facility used Health Stream (Health Stream, Nashville, Tennessee) as an educational tool. Focus group attendees state that this an online service provided education related to multiple topics, including PU care, prevention of falls, hydration, fire safety and Health Insurance Portability and Accountability Act. Each employee was
required to complete three to four computer-based classes per month. Educational programs were available at work and at home through a password protected login. Education was provided related to new skin care initiatives throughout the facility. The unique aspect of education related to PU prevention in the high-ITS facility was the fact educational programming could be accessed through multiple sites and at home to meet the needs of the care providers.

**Theme 2: Electronic Communication/Documentation**

Electronic communication and documentation were operationally defined as various methods of sharing health information with health care providers and users of the health record. Electronic communication and documentation can be as simple as the use of a telephone or fax machine or as advanced to a totally integrated facility-wide electronic health record (EHR). In the low-ITS facility, communication with physicians and outside agencies occurred via telephones and facsimile machine. The low-ITS facility used a paper medical record and the CNA documented exclusively on the activity-of-daily-living sheets and shower sheets. The low ITS staff used paper health records: 24-hour report sheets, activity-of-daily-living sheets, and shower sheets. Staff stated that if a direct care provider was off for two or more days, she or he would need to search though the past 24-hour work sheets by hand to obtain information needed to provide care. Although one computer was available and laboratory results were available online, one direct care provider described the situation as follows, “You don’t use it [the computer] for that; you rely on faxes for the lab results. The Director of Nursing can get in there to use it for lab results but needs a password. The nurses mainly rely on faxes and don’t use the lab reporting.” The computer was used for mandatory reporting of MDS 3.0
(minimum data set) data by a non-direct care provider. The staff did not discuss the incorporation or use of the MDS data for PU prevention or treatment. Communication was described as infrequently incomplete or fragmented, and documentation was limited to RNs and licensed practical nurses.

Respondents in the high ITS-facility described communication and documentation as occurring via the EHR they further noted that all care providers had access to health care information, and were able to document the care provided. As orders were received or plans of care were assigned, intervention task lists were sent to the direct care providers for implementation through color-coded alerts.

**Theme 3: PU prevention strategies**

In the low-ITS facility, the direct care providers reported their facility used, “all of them” [pressure ulcer prevention strategies]. A direct care provider further stated that “Charge nurses do skin assessments every week.” Conversely, it was noted by one direct care provider, “Braden [PU risk assessment] are done on admission and do not reassess.” Another direct care provider reported “…turning sheets are posted in [some] rooms, but most are not.” Another direct care provider reported, “The staff is real good about taking care of skin and we do not have a lot of pressure ulcers here. If the staff sees a mushy heel, for example, they get the patient started on heel protectors and act accordingly right away.” While evidenced-based PU prevention strategies were observed being used in the low-ITS in the primary study (Alexander et al., 2013), staff participating in the focus group reported that strategies were identified and implemented based on individual staff knowledge and judgment. They also noted that regular staff meetings had ceased
due to scheduling difficulties, which further restricted communication related to PU prevention to conversations among the various care providers.

Respondents from the high-ITS facility stated that PU prevention was driven through skin care guidelines and protocols embedded within the EHR. Direct care providers use the shower sheets to document a new reddened skin or area of concern, “There are actual boxes that they fill out indicating what part of the body where items were noticed.” For residents determined to be at increased risk for PU development, respondents reported that they followed the facilities skin care protocol designed by the health care system’s physician and skin care team. The skin care protocols populate task lists for the direct care providers to implement. As an example, when the protocol requires that a patient be turned every two hours, participants noted that a pink box appears on the direct care provider’s task list reminding staff of the need to complete this preventive intervention. Once the task is completed, checked as done and, documented, the pink alert disappears. Skin care tasks for implementation included hydration, hygiene, positioning and nutritional supplementation. Respondents note that preventive intervention are completed by the direct care providers and monitored by the charge nurses. Since the skin care protocol and task lists are embedded within the EHR, direct care providers stated that they were able to identify the interventions required for PU prevention. One direct care provider stated, “Intervention list on computer system: used to remind CNAs about different things to do or watch out for. If a patient has a specific skin issue, it is automatic that they get turned every 2 hours, provide peri-care, barrier cream. Anything the CNAs see, they document and report to charge nurse.”
Discussion

Based on qualitative analysis of staff from two LTC facilities with high and low ITS facilities, we identified three differences in communication strategies related to PU prevention. Ongoing PU prevention education was more available and more easily accessible to the direct care providers in the high-ITS facility. In addition, respondents from the high-ITS facility described multiple avenues for direct care staff to access resident-specific health information and document PU prevention interventions provided. Finally, we concluded that communication strategies for PU prevention used by the high-ITS facility were of superior quality, quantity, and diversity. Collectively, these conclusions suggest that facilities with low-ITS may encounter obstacles when providing PU education to staff, conveying up-to-date resident specific health information, and implementing evidence-based PU prevention guidelines. Further research is needed to determine how a WOC nurse can overcome such obstacles and improve the effectiveness of PU prevention in a low-ITS facility.

Education Opportunities

Whether a LTC facility has high or low ITS, staff require ongoing education regarding skin care and PU prevention. Key components of an evidence-based PU prevention program include risk identification, and prompt implementation of measures to reduce risk, including the following: strategies to minimize pressure, friction and shear; appropriate utilization of pressure redistributing support surfaces; management of incontinence; support for optimal nutrition and hydration; and patient/caregiver education (Wound Ostomy Continence Nurses Society, 2010). Because regular staff meetings had had been discontinued at the low-ITS facility due to scheduling difficulties,
communication was limited to individual conversations. With support of administration, the WOC nurse could reinstitute staff meeting or identify an alternative approach to the provision of essential education. The WOC nurse would need to assess learning needs regarding PU prevention, from both caregiver and administrative perspectives. The WOC nurse could then use the findings to design educational offerings to meet the identified learning needs, based on the agency’s level of ITS (Agency for Healthcare Research and Quality, 2012). Options could include: just-in-time education incorporated into the Skin Care Walking Rounds, face-to-face or online classes on PU prevention strategies, skin care product review (face-to-face or online), hands-on practice for prevention strategies such as positioning and heel elevation, and individual or group counseling of skin care. For individuals unable to attend face-to-face presentation, digital recordings of presentations could be made available for viewing when convenient; if staff wished they could “check out” the recordings for use at home. The WOC nurse could also work with the vendors to obtain access to “free” educational programs or products or could purchase educational materials form the Wound, Ostomy and Continence Nurses Society or National Pressure Ulcer Advisory Panel. Another option is to pair training sessions with a “poster of the month” displayed in staff break areas.

At a more advanced level, the WOC nurse could assist the facility in the development of skin care champions and a Skin Care Team for the facility. If approved by administration, the WOC nurse could also offer Wound Treatment Associate training through the Wound Ostomy and Continence Nurses Society (Wound Ostomy Continence Nurses Society, 2011). The Wound Treatment Associate program is designed for non-specialty licensed direct care providers and medics/corpsmen and provides extensive
education in the areas of PU prevention, wound assessment, and wound management. The program must be facilitated by a certified wound care nurse, who is also responsible for coordinating competency evaluations at conclusion of the program.

**Electronic Communication/Documentation (Information Access)**

To address accessibility of needed information, the WOC nurse should initially determine the specific information needed by each team member and identify the gaps in access. The care provider’s information needs tend to be two-fold: patient specific information and skin care/PU prevention specific information. Patient specific information related to current skin care status, food preferences; fluid needs or restrictions, mobility choices, hygiene and preferred timing of care. Skin care and PU prevention specific information includes evidence-based protocols for PU prevention and specific guidelines for skin or wound. The WOC nurse could then work with administration and direct care providers to review current could review all documentation modes and develop user-friendly format for documentation. Information about pressure prevention practices should be visible and easily accessible; low-ITS strategies for increasing accessibility include development of skin care notebooks kept on each patient care unit, use of informational posters to increase awareness of key prevention strategies, and other visual cues, such as turning clocks placed at the patient’s bedside. Informational packets could be provided for staff use that includes a turning clock for the bedside, head-of-bed elevation reminder poster, facility-specific peri-care recommendations, and standing orders or protocols (Berlowitz, Lukas, Parker, Niederhauser, Silver, Logan, & Ayello, 2011; Wound Ostomy Continence Nurses Society, 2010. For direct care providers with access to smart phones at their workplace,
skin care apps may be purchased or developed to guide care. The NPUAP provides a mobile app available for iPhones, iPads and Android devices for PU prevention and care (National Pressure Ulcer Advisory Panel & European Pressure Ulcer Advisory Panel, 2009) Recently the American Nurses Association, sponsored a competition for development of smart phone applications for PU prevention; the top three winners entries were Mobile HealthWare, Dermatap, and Wound Mender (Murphy, 2013).

Regardless of the level of ITS within the facility, the WOC nurse has the unique opportunity to promote PU prevention though the effective use of information technology. Optimal use of this opportunity this requires knowledge of technology and its potential application to clinical practice. Global steps the WOC nurse should take in optimizing PU prevention include development of a team of essential stake-holders, including Health Information Technology personnel, development of or adoption of a dictionary of terms specific to PU prevention and care, adoption of an evidence-based and nationally accepted protocol for PU prevention and management, and collaboration with Health Information Technology staff to incorporate the protocol into the agency’s EHR system in a user-friendly manner (Health IT Collaboration, 2012).

**Limitations**

Data were exclusively narrative and were limited to personnel from two LTC facilities. We did not follow the LTC facilities related to introduction, adoption, or progression of ITS. Other cofounding variables may have influenced the differences we identified, such as the facility’s business model, the culture of the organization, number and mix of providers, and their receptiveness to change. Finally, the influence of high verse low ITS
on PU prevalence and incidence is not known and additional research is needed to address the magnitude of effect of ITS on PU prevention.

**Conclusion**

Findings from the study suggest that IT may be a useful tool for providing education and communication related to PU prevention and for enhancing documentation of preventive practices (The Wound Ostomy Continence Nurses Society, 2013). In order to use IT, the WOC nurse must become familiar with systems currently used in affiliated facilities and collaborate with the information technology specialists and other clinicians to optimize its impact though integration of evidence-based protocols into practice.

**ACKNOWLEDGEMENTS**

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quick reference guide now available for iPhone, iPad and Android Devices


http://doi.org/10.1016/j.jamda.2009.11.010


Table 2.1

Facility, Shift, Type of Personnel, and Years of Service of the Sample (N=39)

<table>
<thead>
<tr>
<th></th>
<th>High ITS Facility (n)</th>
<th>Range of Experience (yrs)</th>
<th>Low ITS Facility (n)</th>
<th>Range of Experience (yrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Day Shift</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Nurses</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CNA/CMT</td>
<td>5</td>
<td>1–10</td>
<td>3</td>
<td>20–27</td>
</tr>
<tr>
<td>Nurses</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MDS Coord./LPN/RN</td>
<td>5</td>
<td>0.42–11</td>
<td>3</td>
<td>1.5–24</td>
</tr>
<tr>
<td><strong>Evening Shift</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Nurses</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CNA/RMT/CMT</td>
<td>5</td>
<td>2–25</td>
<td>3</td>
<td>1–20</td>
</tr>
<tr>
<td>Nurses (LPN)</td>
<td>2</td>
<td>0.42–25</td>
<td>1</td>
<td>0.17</td>
</tr>
<tr>
<td><strong>Night Shift</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Nurses</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CNA</td>
<td>4</td>
<td>3–13</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td><strong>Administration</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Director/DON Social services director</td>
<td>3</td>
<td>13–21</td>
<td>3</td>
<td>2–30</td>
</tr>
<tr>
<td><strong>IT department</strong></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>IT Staff</td>
<td>2</td>
<td>18–22</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>26</td>
<td>13</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CMT: Certified Medication Technician, CNA: Certified Nurse Assistant, DON: Director of Nursing, IT: Information Technology ITS: Information Technology Sophistication, LPN: Licensed Practical Nurse, MDS Coord.: Minimal Data Set Coordinator, RMT: Restorative Medical Technician, RN: Registered Nurse.
### Table 2.2
Results by Themes and Communication Strategies per Information Technology Sophistication (ITS)

<table>
<thead>
<tr>
<th>Theme</th>
<th>Communication Strategies</th>
<th>Group 1: High ITS</th>
<th>Group 2: Low ITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bedside alert</td>
<td>Laminated picture cards on door to alert providers of resident needs: Honey Bee-thickened liquids, Hummingbird-thickened nectar, Red Socks-fall, Pup-Pressure Ulcer Prevention, Raindrop-hydration, Snow flake-lotion, EHR status board</td>
<td>Informal notes, ADL sheets, turning schedules used inconsistently; direct care providers would like alerts on door jam</td>
<td></td>
</tr>
<tr>
<td>Difficulty with communication</td>
<td>Communication occurred via EHR which was a change from face to face to interaction with EHR (Change in communication style)</td>
<td>Communication reported as short, not shared to all direct care providers or omitted</td>
<td></td>
</tr>
<tr>
<td>Education opportunities</td>
<td>Educational programming available via any facility computer &amp; at home with a password; monthly education &amp; hands on practice; 3-4 educational programs a month; skin care orientation; new program education (laminated door alerts; &amp; monthly meetings</td>
<td>Educational programming available via one computer in a multi-purpose area which had limited access, 1-2 education programs a month</td>
<td></td>
</tr>
<tr>
<td>Electronic communication</td>
<td>Ready access to health care providers via EHR; physician orders &amp; health care orders available on entry into EHR; documented at point of care with use of evidence-based protocols &amp; task lists</td>
<td>Fax machine &amp; telephone and use a paper medical record</td>
<td></td>
</tr>
<tr>
<td>documentation</td>
<td>Integral method of communication, from educational reminders to intervention lists in the EHR</td>
<td>Email not utilized</td>
<td></td>
</tr>
<tr>
<td>E-mail</td>
<td>Evidence-based protocols used as basis for pressure ulcer prevention strategies, along with risk assessments, bedside alerts, &amp; color-coded intervention lists/schedules in EHR</td>
<td>Pressure ulcer risk assessment completed on admission but reassessments reported as inconsistent; turning schedules not in all rooms</td>
<td></td>
</tr>
<tr>
<td>Pressure ulcer prevention</td>
<td>Report sheets incorporated into the EHR &amp; available to direct and non-direct care providers; Computer access available in physician’s office, nurse’s station, resident care wings or residents’ bedside; Information was available for all direct and non-direct care providers.</td>
<td>24 hour report sheet used by nurses as a hand written historical document of new orders; updates &amp; changes in resident’s condition. To retrieve information each 24 hour report sheet must be hand searched</td>
<td></td>
</tr>
<tr>
<td>strategies</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Report Sheets</td>
<td>Walking rounds with nurses’, huddles with in concert with EHR review at bedside with nurses’</td>
<td>Nurses receive verbal reports, CNA receive limited report or report from prior shift CNA</td>
<td></td>
</tr>
<tr>
<td>Verbal report</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Declaration of participation in research, design and development of the following publication:

ANALYSIS OF QUALITATIVE INTERVIEWS ABOUT THE IMPACT OF INFORMATION TECHNOLOGY ON PRESSURE ULCER PREVENTION PROGRAMS: IMPLICATIONS FOR WOUND, OSTOMY, AND CONTINENCE NURSE


In my academic studies, I participated in planned advanced nursing research practicum hours of which one of the expected outcomes was completion of a manuscript for publication. I participated in travel to a long term care facility in southern Missouri. As part of Dr. Alexander’s research study, we met with administrative staff and nursing home personnel. During this time at the long term facility, I participated in observation of charge nurse activities and completion of field note documentation with interrater assessments. I also observed focus group interviews and lead one focus group. In preparation for writing the manuscript, I listened to the audio transcripts for each interview session per personnel category in two long term care facilities, one with low information technology sophistication and one with high information sophistication.
Narrative data were entered into NVIVO qualitative software for analysis. Themes were identified which I verified with Drs. Alexander and Wipke-Tevis. Eight themes were identified; three themes were presented with participant exemplars. Working with Drs. Wipke-Tevis and Alexander, a poster presentation was developed and presented at Midwest Nursing Research Society’s Annual Convention in Dearborn, Michigan in April, 2012, Wound Ostomy Nursing Society Annual Conference in 2011 in an Antonia, Texas and at the Frail Elderly Conference in Columbia, Missouri. Working with Drs. Wipke-Tevis and Alexander, the manuscript was developed and revised and, ultimately, submitted to the *Journal of Wound, Ostomy, and Continence Nursing* for publication.
CHAPTER THREE: 
RESEARCH PROPOSAL

Pressure ulcer prevention is a measure of quality in all healthcare settings, including hospitals. The Centers for Medicare and Medicaid Services (CMS) reimbursement is no longer given to hospitals for hospital-acquired Stage 3 and 4 pressure ulcers (Centers for Medicare and Medicaid Services (CMS), HHS, 2011). While the Braden Risk Assessment Scale (BRAS) is the most commonly utilized tool for pressure ulcer risk identification in U.S. hospitals, it has been questioned related to its subjective nature and omission of physiological factors (Coleman, Nixon, Keen, Wilson, McGinnis, Dealey, Stubbs…Nelson, 2014; He, Liu, & Chen, 2012). Use of quantitative, physiologic data from the electronic health record may provide additional essential information to identify changes in risk for pressure ulcer development in real-time. At present, no such system has been tested in hospitalized patients. Thus, this study was designed to support scientific investigation of an early warning system, the Rothman Index (RI), as a real-time pressure ulcer risk assessment to enhance pressure ulcer risk identification and foster earlier pressure ulcer prevention strategies. The specific aims were as follows:

**Specific Aim 1:** To examine pressure ulcer prevalence, BRAS scores, Rothman Index (RI) scores, and rapid response episodes in adult medical-surgical patients at discharge, using data from the electronic health record.

**Research Question 1a:** Upon discharge, what is the overall prevalence of pressure ulcers at discharge, regardless of ulcer severity, and the prevalence of the most severe category of pressure ulcers at discharge, classified as a Stage 1, Stage
2, Stage 3 or Stage 4, in adult hospitalized medical-surgical patients in a rural Midwestern hospital?

**Research Question 1b:** In adult medical-surgical patients, is there a difference between the average BRAS score for individuals with or without a pressure ulcer at discharge, regardless of ulcer severity?

**Research Question 1c:** In adult medical-surgical patients, is there a difference between the average RI score for individuals with and without a pressure ulcer at discharge, regardless of ulcer severity?

**Research Question 1d:** In adult medical-surgical patients, is there an association between experiencing a rapid response episode any time during the hospitalization and the presence or absence of a pressure ulcer at discharge, regardless of ulcer severity?

**Research Question 1e:** Is there an association between the BRAS score and the RI score upon discharge in adult medical-surgical patients?

**Specific Aim 2:** To compare BRAS scores, rapid response episodes, RI scores, nursing staff reviews of the RI scores and hospital readmission within 30 days in adult medical-surgical patients discharged with or without a pressure ulcer, regardless of ulcer severity using data from the electronic health record.

**Research Question 2a:** Is there a difference between the 30-day hospital re-admission rates for adult medical-surgical patients discharged with or without a pressure ulcer, regardless of ulcer severity?

**Research Question 2b:** Of the patients readmitted within 30 days of hospital discharge, is there an association between BRAS risk categories (Low
Risk, Moderate Risk, Highest Risk), and patients discharged with or without a pressure ulcer, regardless of ulcer severity.

**Research Question 2c:** Of the patients readmitted within 30 days of hospital discharge, is there an association between the RI risk categories (Low Risk, Moderate Risk, Highest Risk) and patients with or without a pressure ulcer, regardless of ulcer severity?

**Research Question 2d:** Is there a relationship between experiencing a rapid response episode during the hospitalization and hospital readmission within 30 days in adult medical-surgical patients discharged with or without a pressure ulcer, regardless of ulcer severity?

**Research Question 2e:** Of the patients readmitted within 30 days of hospital discharge, is there a difference in average number of nurse RI reviews between patients discharged with or without a pressure ulcer, regardless of ulcer severity?

Assessment of risk for adverse events is an essential task for all health care providers. Early awareness of potential risks allows the health care provider to implement preventative strategies. An efficient and effective system is needed to guide health care providers in real-time.

**Background and Significance**

Identifying patients at risk for pressure ulcer development in the health care setting and communicating this risk to health care providers is a challenge in today’s healthcare environment (Alexander & Madsen, 2009; Alexander & Madsen, 2012;
Presently, the BRAS is the most commonly used pressure ulcer risk assessment scale in the U.S. (K. Cooper, 2013). BRAS pressure ulcer risk assessments are completed at specified times: on admission, after a change in the patient’s condition, daily, or as defined by the health care organization. Between these times, however, opportunities are lost for identification of risk and implementation of pressure ulcer prevention strategies. Additional limitations of the BRAS are its subjective nature, the inability to easily incorporate quantitative, physiologic pressure ulcer risk factors, (Wound Ostomy and Continence Nurses Society, 2010), and its relatively weak predictive ability (Chou, Dana, Bougatsos, Blazina, Starmer, Retiel, & Buckley, 2013). Furthermore, many other physiologic pressure ulcer risk factors not included in the BRAS have been identified (García-Fernández, Agreda, Verdú, & Pancorbo-Hidalgo, 2014a). Currently, there is no simple way for the bedside nurse to gather information on all these risk factors and interpret a patient’s true pressure ulcer risk.

Research has indicated that excellent communication between staff members was vital to effective implementation of pressure ulcer prevention and management interventions in a vulnerable elderly population (Alexander, Pasupathy, Steege, Strecker, & Carley, 2014; Alexander et al., 2013; Fossum et al., 2013). The use of information technology, as a communication tool, has been suggested to help improve pressure ulcer prevention and management (Shepherd et al., 2015). Vital information gathered from ongoing physical assessments, vital signs, and laboratory values provided relevant pressure ulcer prevention risk data. In acute care, identification of pressure ulcer risk factors within a clinical decision support system integrated into the electronic health
record could provide the healthcare provider with the knowledge through an early warning system (Berner, 2012). In the electronic health record, retrieval of these risk factors is now possible. The early warning system could aggregate all pressure ulcer risk factors and present them in a way to enhance communication among the providers. Evidence-based pressure ulcer prevention strategies could then be communicated to guide the health care team in pressure ulcer prevention through the clinical decision support system (Berner, 2012). The availability of accurate, point of care clinical data may help improve the quality of pressure ulcer prevention management in hospitalized adults. No such system had been developed for the general medical-surgical hospitalized patients at the time of the study.

**Innovation**

Providing the medical-surgical nurse with a real-time pressure ulcer risk assessment tool would greatly increase the nurse’s ability to identify patients at risk for pressure ulcer development. The RI tool, which is integrated into the electronic health record, could be easily accessible as an early warning system which would trigger early identification of patients at risk and allow the nurse to implement additional pressure ulcer prevention strategies as needed to decrease the patient’s relative risk for HAPU. No previous studies were found that examined the relationships between the BRAS, the RI, rapid response episodes, and readmission to the hospital within 30 days.

If the RI is positively related to the BRAS, nurses may consider use of the RI as a real-time pressure ulcer risk assessment. Use of the RI in addition to the BRAS will augment the nurses’ clinical judgment in the care of at risk medical-surgical patients. Use of the BRAS paired with the RI will enhance nurses’ awareness by providing the patient’s
status at a glance, trigger interdisciplinary care planning when there is a subtle change or negative trend in risk factors’, and provide a mechanism for ongoing monitoring. A real-time pressure ulcer risk assessment will provide the most current information that is easily accessible and can signal or trigger for the nurse to intervene. Pressure ulcer prevention strategies and/or interventions may be initiated earlier and decrease risk for skin injury.

**Conceptual Framework**

This study used the conceptual framework of James Reason’s Risk Analysis and Error Detection, also known as the Swiss Cheese model. The framework is a model of risk analysis and risk management used initially in aviation and engineering and most recently in health care (Reason, 1990). The risk analysis and risk management model is a model of error detection and safety that incorporates constructs of accident prevention and accident causation. The model demonstrates how the design of continuous processes may facilitate decision making by making correct decisions easy and incorrect decisions hard. Furthermore, the model facilitates correct responses and mitigates against incorrect response or actions. Sensitive feedback systems, the ability to respond rapidly to the perceived or actual safety alteration, and continuous monitoring to complete the feedback loop is required of this process (Reason, 1990).

The model uses the metaphor of Swiss cheese. Each slice of Swiss cheese acts as a barrier or defense against untoward events. The multiple layers of sliced cheese are defenses against untoward events. The holes within the slices of Swiss cheese are small and usually allow insignificant errors. When the holes are large, other layers block the errors, but when the holes line up, a trajectory of failure occurs. The holes in the cheese
may be considered opportunities for *active* and *latent* failures that continually widen, narrow, or shift in position related to the condition. When the holes line up even for a short period of time an accident, injury, or untoward event may occur (Reason, 1990).

Active failures occur as a *slip, lapse, mistake, or violation.* A slip is an attentional failure, which may include an omission, reversal, wrong order, or mistiming error. Lapse failures are memory failures where planned actions are omitted or simply forgotten. Mistakes are considered knowledge-based errors--using good knowledge incorrectly or bad knowledge correctly. Violations are intentional behaviors of misconduct. Violations are considered routine, exceptional, or acts of sabotage.

Active failures are short-lived unsafe acts and the adverse outcomes are close to the unsafe behavior (Reason, 1990). Latent conditions are events that are error provoking, but are not seen contingent to the behavior. Latent failures lie dormant until an active failure or trigger occurs. A latent failure could occur as a result of administrative decisions, time limitations, stress, pressure, inadequate equipment, fatigue, inexperience, or lack of education (Reason, 1990). Latent failures, when experienced, produce long-term effects that may be devastating to the organization (Reason, 1990).

In terms of pressure ulcer prevention, active failures may include attentional failures which place the hospitalized medical-surgical patient at an increased risk for skin break down. Examples include omission of BRAS, identification of an *at-risk* patient without communicating the risk in a hand-off report, or forgetting to implement pressure ulcer prevention strategies.
Methodology

Design

This study was a retrospective, secondary data analysis from a prior, unpublished study (Phillips, Shepherd, Jochem, & Mosely, 2016) and employed a descriptive correlational study design using a limited data set from the electronic health record of a rural Midwestern community hospital. The data were acquired from three distinct time periods: January 2012-July 2012, September 2012-February 2013, and March 2013-August 2013. The time periods were determined based on the primary study which examined the impact of implementation of and staff nurse re-education on the use of the RI in the rural Midwestern hospital (Phillips et al., 2016). This design was chosen to examine the relationships between pressure ulcer prevalence upon hospital discharge and the BRAS, RI, rapid response episodes, and 30 day readmission in a rural Midwestern hospital. The BRAS was operationalized as the standard for prediction of pressure ulcer development. The RI score was the variable of assessment (Polit & Beck, 2012). The outcome variable was pressure ulcer period prevalence. Additional variables of interest included in the limited data set were age, medical or surgical unit, discharge diagnosis of a pressure ulcer, stage of pressure ulcer at discharge, length of stay number of nurse RI reviews, rapid response episodes, and readmission within 30 days.

Protection of Human Subjects

Prior to initiation of study procedures, approval was obtained from the University of Missouri’s Health Sciences Institutional Review Board and Citi training documentation (Appendix B and C) and the Blessing-Rieman College of Nursing Institutional Review Board (Appendix D). Organizational consent was obtained from the
Research Review Committee and Health Insurance Portability and Accountability Act and Privacy Board at the hospital that was the site of the study (Appendix E). The minimum amount of Protected Health Information needed for the research was used and accessed only by the Health Information Management (HIM) Department.

**Setting and Sample**

The setting was a medical and surgical unit in a rural, Midwestern, not-for-profit, community hospital that used Eclipses Allscripts electronic health record and the RI. Each unit had a 40-patient bed capacity. The average daily census on the medical unit was 31 patients a day, while the surgical unit average daily census was 33 patients per day.

The sample included patients who were hospitalized on the medical or surgical unit during one of the following time periods: January 1, 2012 to July 31, 2012, September 1, 2012 to February 29, 2013, and March 1, 2013 to August 31, 2013. These dates were determined by the primary study and coincided with an evaluation of the impact of staff nurse education and training on the use of the RI (Phillips et al., 2016). The first time period addressed to staff nurse use of the RI after initial RI education. The second time period corresponded to staff nurse re-education on use of the RI, and the third time frame examined the sustainability of the staff nurse education provided.

**Inclusion and Exclusion criteria.** Data were included from hospitalized patients who were ≥18 years old and present on the medical or surgical unit in a rural Midwestern hospital during the time frame of interest. Data were excluded for hospitalized patients < 18 years of age, as well as those in intensive care, cardio-vascular care, psychiatric care,
maternity, labor and delivery, and pediatrics. Data also were excluded from patients hospitalized for observation or patients with no BRAS or RI data points.

**Instruments and Variables**

**Braden Risk Assessment Scale.** The Braden Risk Assessment Scale (BRAS) was used to determine pressure ulcer risk. The BRAS has six subscales: sensory perception, moisture, activity, mobility, nutrition, and friction and shear. The total score can range from 6 to 23 and the lower the score the higher the pressure ulcer risk. BRAS Risk can be categorized using specific score ranges: mild risk (15-18), moderate risk (13-14), high risk (10-12) and very high risk (< 9) (Bergstrom, Braden, Laguzza, & Holman, 1987). Although developed for use in the long-term care setting, the validity and reliability of the BRAS has been studied in variety of healthcare settings (García-Fernández, Pancorbo-Hidalgo, et al., 2014; Pancorbo-Hidalgo, García-Fernández, Lopez-Medina, & Alvarez-Nieto, 2006; Serpa, Santos, Campanili, & Queiroz, 2011). The BRAS sensitivity ranged from 83%-100% with specificity varying from 64%-94% and an intrarater reliability of 0.99 for registered nurses (Bergstrom, Braden, et al., 1987).

Permission letter to use Braden scale provided in (Appendix F).

In the Midwestern rural hospital on the medical-surgical units, the BRAS was integrated into the electronic health record and completed on admission to the hospital, at a change of condition, and daily. The registered nurses on the medical and surgical units in that rural Midwestern hospital received training on the BRAS and the RI in orientation and periodically during employment. In orientation, the BRAS was reviewed including practice scenarios and documentation in Eclipse Allscripts. For this study, the BRAS score at discharge was utilized as the variable of interest. BRAS Risk scores were
intended to be categorized as: No Risk (19-23), Mild Risk (15-18), Moderate Risk (13-14), High Risk (10-12) and Very High Risk (≤ 9). Due to low frequency counts in the risk categories, the BRAS No Risk and Mild Risk categories were collapsed into one Low Risk category (15-23); High Risk and Very High Risk categories also were collapsed into one Highest Risk category (6-12). Thus, the three categories for the purposes of BRAS Risk analysis were: Low Risk (15-23), Moderate Risk (13-14), and Highest Risk (6-12).

**Rothman Index.** The Rothman Index (RI) is an early warning system designed to assist the healthcare providers in identifying subtle changes in patients’ condition over time and to predict patients’ discharge readiness and care needed after discharge (Bradley, Yakusheva, Horwitz, Sipsma, & Fletcher, 2013). Embedded within the electronic health record, the RI can be used to track and trend individual or groups of patients’ progress. The RI incorporates 26 variables from the electronic health record which fall into the following categories: vital signs (temperature, systolic blood pressure, diastolic blood pressure, heart rate, respiratory rate, arterial oxygen saturation), ongoing nursing assessments (cardiac, food/nutrition, gastrointestinal, genitourinary, musculoskeletal, neurological, peripheral-vascular, psychological/coping, respiratory, safety/fall, skin/tissue, as well as heart rhythms and Braden Scores) and laboratory tests (Blood Urine Nitrogen, Creatinine, White Blood Count, Hemoglobin, Chloride, Sodium, Potassium) (M. Rothman, Solinger, Rothman, & Finlay, 2012; S. Rothman, Rothman, & Solinger, 2013b). Within the RI, laboratory results are designed to decline in importance within 24 hours of being drawn and have no impact on the overall RI score after two days. Nursing assessment data, based on the
head to toe assessment documentation, are incorporated into the RI using the binary code of “Met” or “Not Met” and is dependent on whether the documented assessment meets the minimum accepted standards for each physiologic system parameter (Table 3.1), (S. Rothman et al., 2013b).

The score may range from a low of -91 (critically ill patient) to a high of 100 (optimal patient) (Bradley et al., 2013). A lower total score indicates higher acuity and increased risk for adverse events (Finlay, Rothman, & Smith, 2014). Construct validity of the Rothman Index has been established for 30-day readmissions, 24-hour mortality, discharge disposition, and mortality within one month of discharge (M. Rothman, Rothman, & Beals, 2013a; S. Rothman et al., 2013b). Additionally, the Rothman Index has been found to be superior to the Modified Early Warning Score for the prediction of 24-hour mortality in adult, medical-surgical patients (Finlay et al., 2014). Additional studies have demonstrated the validity of using decreasing RI scores to predict post-operative complications, unplanned medical or surgical intensive care unit readmission, adverse events in the intensive care unit, and when palliative care should be initiated.

For this study, the RI score at discharge was utilized as the variable of interest. RI scores were intended to be categorized as: low risk (65-100), moderate risk (40-64), high risk (31-40) and very high risk < 30. Similar to the BRAS, due to small frequencies RI High Risk and RI Very High Risk were collapsed into a Highest Risk category (≤40). Thus, the three categories for the purposes of RI risk analysis were: Low Risk (65-100), Moderate Risk (40-64), and Highest Risk (≤40). Permission letter to use Rothman Index provided in (Appendix G).
**Pressure ulcer.** A pressure ulcer was defined as a “localized injury to the skin and/or underlying tissue usually over a bony prominence, as a result of pressure, or pressure in combination with shear” (National Pressure Ulcer Panel Advisory Panel, 2012). If the patient had a pressure ulcer on admission to the hospital, it was documented as present-on-admission and staged related to its tissue involvement and depth. A pressure ulcer which developed while hospitalized was documented in the electronic health record as a hospital-acquired pressure ulcer (HAPU) and was also staged related to its tissue involvement and depth (Stotts, Brown, Aydin, & Donaldson, 2012). Due to the very small number of HAPU that developed during the study time periods, the variable of interest for the study became period prevalence of pressure ulcers.

**Period prevalence.** The period prevalence of pressure ulcers was determined based on the previously described study time periods. Period prevalence is the proportion of a population that has a given condition, in this case a pressure ulcer, at some time during a given period and includes people who already have the condition at the start of the study period (i.e. present on admission) as well as those who acquire it during the period (i.e. HAPU) (National Pressure Ulcer Advisory Panel, 2014) For this study, the formula by which period prevalence was calculated as follows: The number of individuals who had a pressure ulcer over a specific time period divided by the total number of individuals in the study population over the same specific time period multiplied by 100 (National Pressure Ulcer Panel Advisory Panel, 2012). Period prevalence formula is provided in (Appendix H).

**Hospital readmission within 30 days.** Hospital readmission is defined as an unplanned admission within 30 days of a discharge from the same or other hospital
The Health Information Management (HIM) department personnel captured readmission within 30 days through a validated computer program, by checking dates of discharge and subsequent dates of admissions.

**Number of RI reviews.** The number of RI reviews is a tabulation of the number of times the nurse accessed the RI to review the RI profile per patient while using the electronic health record. The nurse may access the RI in the process of providing direct patient care, monitoring status changes in cohorts of patients, and while sharing information in hand-off reports. For this study, the variable of interest was the average number of RI reviews.

**Rapid Response Episodes.** A rapid response episode was defined as an event when a hospitalized patient experienced deterioration in their health status that required immediate life sustaining interventions. Rapid response episodes were the number of times a rapid response team was activated during the identified study time periods per patient. For this study, the variable of interest was the presence of a rapid response episode. If a patient had more than one rapid response episode during their hospital stay, it was counted only once.

**Data Testing Prior to Data Collection**

Data were collected by the rural Midwestern facility’s HIM department personnel. The HIM department’s personnel built and verified accuracy of the computer program to collect relevant data. HIM department personnel conducted a pilot test of the computer program under the direction of the HIM Director. Verification of accuracy was completed prior to collection of data.
**Data Collection.** Data were collected though the validated computer program (as listed above) for the primary, unpublished study (Phillips et al., 2016). This study utilized a limited data set which consisted of the following patient variables:

- Length of stay in days
- Case mix index
- Discharge diagnosis (include all)
- Discharge disposition
- Re-admission within 30 days from discharge
- Number of rapid responses team calls
- RI 48 hours prior to patient death in hospital
- RI score at discharge
- Number of times RI reviewed/used
- Braden score at discharge
- Visit date
- Discharge date

**Data Management**

The minimum amount of Protected Health Information needed for the research was used and was accessed only by the HIM Department. Each set of scores was identified and assigned participant numbers in the limited data set. After the limited data set was produced from the electronic health record, HIM personnel under the direction of the HIM Director exported the data into Microsoft Excel version 2010 (Redmond, Washington, USA) with predetermined parameters. The HIM director removed the participant numbers prior to export. The password protected Excel file of the limited data
set was provided to the Principal Investigator on a secure external hard drive following hospital protocol and policies. After transfer of the limited data set to the Principal Investigator, HIM deleted the files used to create the Excel file and the limited data set. The HIM department personnel maintained the computer program for future studies. The data were then saved in a secure password protected Box account at the University of Missouri, Sinclair School of Nursing. Only the PI, the student’s doctoral program committee, and biostatistician had access to the limited data set. The files will be maintained for a minimum of seven years following the completion of the study.

**Data Analysis**

Data were cleaned and analyzed using the IBM Statistical Package for the Social Sciences (SPSS) Version 22 (Chicago, Il., USA). The verified data were assessed and cleaned for outlier values. Analysis began with the evaluation of frequency distributions of all variables, including minimum and maximum, means, median, mode, kurtosis, and skewness. Values that were not possible were identified and considered errors and not included in the analysis.

The differences between groups of patients with pressure ulcers and without pressure ulcers were described using frequencies, percentages, means, and standard deviation regarding factors of age, length of stay, Pressure Ulcer Stage (Stage 1 Stage 2, Stage 3, Stage 4, or Unstageable), number of 30 day readmissions, number of nursing staff reviews of RI, number of rapid response episodes, and BRAS and RI scores at discharge (Polit & Beck, 2012). Period prevalence rates for pressure ulcers were calculated within the study time period and were separated by demographic or outcome characteristics. To determine the association between the BRAS and the RI, Spearman
rho correlation coefficients were calculated based upon the distribution of the RI and BRAS data. If continuous data were normal, two-sample t-tests were used to describe differences for patients who had Stage 1, Stage 2, Stage 3, Stage 4, or Unstageable pressure ulcers upon discharge. If data were non-normal or other assumptions were not met, appropriate non-parametric methods were used instead. Chi-square tests were calculated to determine associations between categorical outcomes of interest and Stage (Stage 1, Stage 2, Stage 3, Stage 4, and Unstageable pressure ulcers) upon discharge. All assumptions for chi-square methods were checked and adjusted if needed. Listed below is the statistical analysis plan per research question.

**Specific Aim 1:** To examine pressure ulcer prevalence, BRAS scores, RI scores, and Rapid Response episodes in adult medical-surgical patients at discharge, using data from the electronic health record.

**Research Question 1a:** Upon discharge, what is the overall prevalence of pressure ulcers at discharge, regardless of ulcer severity, and the prevalence of the most severe category of pressure ulcers at discharge, classified as a Stage 1, Stage 2, Stage 3 or Stage 4, in adult hospitalized medical-surgical patients in a rural Midwestern hospital? To address research Question 1a, the period prevalence of pressure ulcers were calculated within the study time period.

**Research Question 1b:** In adult medical-surgical patients, is there a difference between the average BRAS score for individuals with or without a pressure ulcer at discharge, regardless of ulcer severity? To address Research Question 1b, a two-sample t-test was utilized to determine the difference in the
average BRAS scores for individuals with and without a pressure ulcer, regardless of ulcer severity.

**Research Question 1c:** In adult medical-surgical patients, is there a difference between the average RI score for individuals with and without a pressure ulcer at discharge, regardless of ulcer severity? To address Research Question 1c, a two-sample t-test was utilized to determine the difference in the average RI scores for individuals with and without a pressure ulcer, regardless of ulcer severity.

**Research Question 1d:** In adult medical-surgical patients, is there an association between experiencing a Rapid Response episode any time during the hospitalization and the presence or absence of a pressure ulcer at discharge, regardless of ulcer severity? To address Research Question 1d, a Chi-square of association was utilized to determine the association between experiencing a Rapid Response episode and the presence or absence of a pressure ulcer at discharge, regardless of ulcer severity.

**Research Question 1e:** Is there an association between the BRAS score and the RI score upon discharge in adult medical-surgical patients? To address RQ 1e, Spearman’s rho correlation was utilized to determine the association between the BRAS and the RI.

**Specific Aim 2:** To compare BRAS scores, rapid response episodes, RI scores, nursing staff reviews of the RI scores and hospital readmission within 30 days in adult medical-surgical patients discharged with or without a pressure ulcer, regardless of ulcer severity using data from the electronic health record.
**Research Question 2a:** Is there a difference between the 30-day hospital readmission rates for adult medical-surgical patients discharged with or without a pressure ulcer, regardless of ulcer severity? To address Research Question 2a, a Chi-square test for difference in proportions was utilized to determine the difference between 30-day re-admission rates in adult medical surgical patients discharged with or without a pressure ulcer, regardless of ulcer severity.

**Research Question 2b:** Of the patients readmitted within 30 days of hospital discharge, is there an association between BRAS risk categories (Low Risk, Moderate Risk, Highest Risk), and patients discharged with or without a pressure ulcer, regardless of ulcer severity. To address Research Question 2b, Chi-square was utilized to determine the association between BRAS risk categories (Low Risk, Moderate Risk, Highest Risk), and patients with or without pressure ulcers, regardless of ulcer severity.

**Research Question 2c:** Of the patients readmitted within 30 days of hospital discharge, is there an association between the RI risk categories (Low Risk, Moderate Risk, Highest Risk) and patients with or without a pressure ulcer, regardless of ulcer severity? To address Research Question 2c, Chi-square was utilized to determine the association between RI risk categories (Low Risk, Moderate Risk, Highest Risk) and patients with or without pressure ulcers, regardless of ulcer severity.

**Research Question 2d:** Is there a relationship between experiencing a Rapid Response episode during the hospitalization and hospital readmission within 30 days in adult medical-surgical patients discharged with or without a
pressure ulcer, regardless of ulcer severity? To address Research Question 2d, a Cochran-Mantel-Haenszel Statistic was utilized to determine the association between patients who experienced a rapid response episode during the hospitalization, re-admission within 30 days, and patients discharged with or without a pressure ulcer, regardless of ulcer severity.

**Research Question 2e:** Of the patients readmitted within 30 days of hospital discharge, is there a difference in average number of nurse RI reviews between patients discharged with or without a pressure ulcer, regardless of ulcer severity? To address Research Question 2e, a two-sample t-test was utilized to determine the difference between the average numbers of RI nurse review for patients discharged with or without a pressure ulcer, regardless of ulcer severity.

**Protection of Human Subjects**

**Risks to Human Subjects**

This study was exempt.

**Recruitment and Consent Procedures**

Participation within this study was addressed at Health Sciences-Institutional Review Board at University of Missouri-Columbia and Blessing Rieman College of Nursing Institutional Review Board. Exempt status was granted. A limited data set was used to provide protection of privacy, Health Insurance Portability and Accountability Act adherence, and human safety.

**Health Insurance Portability and Accountability Act Authorization**

Health Insurance Portability and Accountability Act authorization were not sought, since a limited data set was requested with only the minimal data needed that
does not include any individually identifiable Protected Health Information. The PI believed that this minimal risk study could not be carried out without a waiver of informed consent. The Privacy Board form was completed by the PI and respective research team members.

The minimum amount of PHI needed for the research was downloaded by the Health Information Technology (HIM) Department which created a limited data set in an Excel file. HIM transmitted the limited data set per the rural Midwestern Hospital protocol and policy. Data storage was in a database. Following the transmission of the limited data set and confirmation of receipt of the data by the Principal Investigator, the HIM personnel deleted all records with Protected Health Information. After completion of the study, the Principal Investigator will keep the limited data set and analysis of the data on a secured drive in a password protected file and on a storage device in a locked cabinet for seven years. The researcher believes that the benefits of the research findings will outweigh the small privacy risk.

A waiver of informed consent would not affect the privacy rights of the patients whose medical records are used to retrieve the research data, because all data is in a limited data set. Conduction of the study required collection of the minimum amount of data necessary to successfully complete the study, limited access to the data, and complete de-identification of any data released to the Principal Investigator.

**Protection Against Risks**

In this study, a limited data set of Protected Health Information was provided to the Principal Investigator and research team. The HIM Department assigned key technicians and professionals to de-identify all Protected Health Information prior to
sending it to the Principal Investigator. As employees of the rural Midwestern hospital, protecting the patient’s private information is a condition of employment.

HIM-specified personnel were the only ones with access to the data that contains identifiable Protected Health Information. HIM stored the data that contains identifiable Protected Health Information. Transmission and database storage of the Protected Health Information comply with Health Insurance Portability and Accountability Act standards. Access to the database has been limited to the key HIM employees. The HIM personnel are not expected to view any data in the database for reasons other than to ensure the proper operation of the system. HIM removed identifiers and sent the limited data set in an encrypted file to the Principal Investigator using the rural Midwestern hospital protocol and policies. The Principal Investigator notified HIM when the file was received and saved. The Principal Investigator and research team were the only ones with access to the limited data set which was in a password protected secure file. Analysis and summation of the findings were prepared. The Principal Investigator and research team will inform the HIM, Institutional Review Board, and rural Midwestern hospital when the research study has been completed. The study ensures that the Principal Investigator and research team have no access to individually identifiable Protected Health Information, and therefore they are unable to release or compromise Protected Health Information. The Principal Investigator will keep the limited data set and the data analysis for seven years on a secure drive and/or an electronic storage device.

**Protection of Confidentiality**

All possible measures to protect the patients’ Protected Health Information, privacy, and confidentiality were in accordance with hospital policies and federal
regulations. Only a limited data set was shared with the Principal Investigator and the research team. The confidentiality of the dataset was carefully guarded. The study was designed so that the Principal Investigator and research team had no access to individually identifiable Protected Health Information, and therefore they were unable to release or compromise the Protected Health Information. Transmission and database storage of Protected Health Information was according to Health Insurance Portability and Accountability Act standards. Access to the database was limited to the key HIM employees. The HIM personnel as a condition of employment are not expected to view any data in the database for reasons other than to ensure the proper operation of the system. After the study limited data set was sent to and received by the Principal Investigator, the links between Protected Health Information and the study-specific randomly assigned participant number, and any of the remaining Health Insurance Portability and Accountability Act identifiers were deleted by HIM. Use of the limited data set for the study was in a secure area, behind closed doors to enhance confidentiality.

**Risk-Benefit Ratio: Anticipated Benefits to the Participants and Others**

The benefit of participating in this study was limited to participation in research that contributes to knowledge about pressure ulcer risk assessment, management and prevention. The anticipated benefits are three-fold:

- **Patient:** Injury prevention, pressure ulcer prevention.

- **Nurse:** Real-time guidance on individual or groups of patients at risk so appropriate pressure ulcer prevention strategies may be implemented.

- **Organizational:** Appropriate utilization of resources for pressure ulcer prevention.

**Importance of the Knowledge to be Gained**
Researchers benefit from the results that contribute to knowledge relative to pressure ulcer risk assessment, management, and prevention. If the BRAS and RI are determined to have a strong correlation for pressure ulcer development, the nurses may pair the RI with the BRAS to support earlier interventions and enhance clinical decisions by the nurse. If it were known that deteriorating patient conditions in adult medical-surgical patients, such as those identified by the RI early warning system were associated with the development of HAPUs, then nurses could modify their pressure ulcer intervention strategies to help prevent adverse patient outcomes.
Table 3.1

*Rothman Index Nursing Assessment Standards*

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardiac</td>
<td>Pulse regular, rate 60-100 BPM, skin warm and dry. Blood pressure less than 140/90 and no symptoms of hypotension</td>
</tr>
<tr>
<td>Food/Nutrition</td>
<td>No difficulty with chewing, swallowing or manual dexterity. Patient consuming 50% of daily diet ordered as observed or stated</td>
</tr>
<tr>
<td>Gastrointestinal</td>
<td>Abdomen soft and non-tender. Bowel sounds present. No nausea or vomiting. Continent. Bowel pattern normal as observed or stated</td>
</tr>
<tr>
<td>Genitourinary</td>
<td>Voids without difficulty. Continent. Urine clear, yellow to amber as observed or stated. Urinary catheter patent if present.</td>
</tr>
<tr>
<td>Musculoskeletal</td>
<td>Independently able to move all extremities and perform functional activities as observed or stated (includes (assistive devices).</td>
</tr>
<tr>
<td>Pain</td>
<td>Without pain or VAS (visual analogue pain scale), &lt; 4 or experiencing chronic pain that is being managed effectively.</td>
</tr>
<tr>
<td>Neurological</td>
<td>Alert, oriented to person, place, time, and situation. Speech is coherent.</td>
</tr>
<tr>
<td>Peripheral/Vascular</td>
<td>Extremities are normal or pink and warm. Peripheral pulses palpable. Capillary refill &lt; 3 seconds. No edema, standard numbness or tingling</td>
</tr>
<tr>
<td>Psychosocial</td>
<td>Behavior appropriate to situation. Expressed concerns and fears being addressed. Adequate support system.</td>
</tr>
<tr>
<td>Respiratory</td>
<td>Resp, 12-24/min. at rest, quiet and regular. Bilateral breath sounds clear. Nail beds and mucus membranes pink. Sputum clear, if present.</td>
</tr>
<tr>
<td>Safety/Fall risk</td>
<td>Safety/fall risk factors are not present. Patient is not a risk to self or others.</td>
</tr>
<tr>
<td>Skin/Tissue</td>
<td>Skin clean, dry, and intact with no reddened areas. Patient is alert, cooperative and able to reposition self independently. Braden scale &gt; 15</td>
</tr>
</tbody>
</table>

*Note. BPM = beats per minute, Min = Minute, Resp. = respiratory VAS = Visual analogue Pain Scale. Modified and adapted with permission from: (S. Rothman et al., 2013b).*
CHAPTER FOUR:

Rothman Index as a Predictor of Rapid Response Episode Occurrence, Pressure Ulcer Status at Discharge and Hospital Readmission in Adult Medical-Surgical Patients (Shepherd, M. M., Wipke-Tevis, D. D., & Leary, E. Manuscript in preparation).

As the principal investigator, Marilyn Shepherd took the lead in designing the research, obtaining access to the limited dataset, obtaining Institutional Review Board approval; cleaning, analyzing, and interpreting the data; and writing the final manuscript. Dr. Deidre Wipke-Tevis assisted with designing the research proposal, revising the specific aims, reviewing the analysis and interpreting the results, as well as contributing to the development of the final manuscript. Dr. Emily Leary assisted with revising the specific aims, designing the data analysis plan; guiding the cleaning, analysis and interpretation of the data, and contributing to the development of the final manuscript.

Abstract

Reimbursement changes in Medicare and Medicaid have tied prevention of adverse events and hospital acquired conditions to advancements in health information technology. Accordingly, early warning systems are being incorporated into the EHR of many hospitals. Although early warning systems address risk identification, no such system has been tested for PU risk. The purpose of this research was to determine if the RI would be useful for the prediction of (1) pressure ulcer risk, (2) pressure ulcer status at discharge, (3) rapid response episode occurrence, and (4) unplanned hospital readmission within 30 days in adult medical-surgical patients. This study was a secondary analysis of
retrospective data from a limited data set from a rural, Midwestern, not-for-profit community hospital that had incorporated both the BRAS and the RI into their Eclipses Allscripts electronic health record (EHR). Data were abstracted at discharge for patients ≥18 years of age from the medical and surgical units (n=7567 unique patient discharges) during three, six month time periods. The BRAS and RI risk scores upon discharge were strongly correlated ($r_s = 0.771$, $p < .001$) in adult medical-surgical patients. Patients discharged with a PU had a longer length of stay ($p < .001$), a greater frequency of rapid response episodes ($p < .02$), lower BRAS risk score ($p < .001$), lower RI risk score ($p < .001$), and greater frequency of readmission within 30 days of discharge ($p < .001$) than patients discharged without a PU. Readmission within 30 days of hospital discharge was associated with PU presence at discharge ($p < .001$). An early warning system, such as the RI, may be a useful tool not only for PU risk identification, but also as a predictor for adverse events, such as extended length of stay, clinical deterioration, and readmission within 30 days of hospital discharge. Identification of risks, in real time, will provide essential information to healthcare providers and foster clinical decision making to lessen or avoid the untoward effects of adverse events. Rothman Index as a Predictor of Rapid

Key words: Response Episode Occurrence, Pressure Ulcer Status at Discharge, and Hospital Readmission in Adult Medical-Surgical Patients
Health care safety and quality care remain high priorities in U.S. hospitals, which was motivated in part by the Institute of Medicine’s landmark report *To Err is Human: Building a Safer Health System* (Kohn et al., 2000). In spite of a focused, nationwide effort on quality and safety over the last 20 years, healthcare errors, hospital acquired conditions, and preventable patient deaths still occur at an alarming rate (James, 2013). The use of health information technology to improve healthcare quality and safety has been recommended (Zhang, Seblega, Wan, Unruh, Agrio, & Miao, 2013). Indeed, the Patient Protection and Affordable Care Act and the American Recovery and Reinvestment Act specifically include health information technology provisions to help facilitate the incorporation of guidelines, alerts, and clinical decision support systems into electronic health records (Kocher, Ezekiel, & DeParle, 2010; *The American Recovery and Reinvestment Act of 2009: Information center*, 2009; *The Patient Protection and Affordable Care Act*, 2010).

Two important indicators of quality receiving considerable attention are pressure ulcers (PU) and hospital readmission within 30 days of discharge (Lyder, Wang, Metersky, Curry, Kliman, Verzier, & Hunt, 2012). Undeniably, PU and other skin integrity issues are common adverse events in hospitals resulting in an estimated annual cost of nearly $500 million (David, Gunnarsson, Waters, Horblyuk, & Kaplan, 2013; Naessens, Cambell, Huddleson, Berg, Lefante, Williams, & Culberson, 2009). Moreover, hospital readmissions cost the Centers for Medicare and Medicaid Services (CMS) approximately $26 billion/year (Boozary, Manchin, & Wicker, 2015). Of note, hospital-acquired pressure ulcers (HAPU) are a predictor for readmission within 30 days of hospital discharge in both community dwelling adults and nursing home residents.
Furthermore, high risk, long stay nursing home residents with a PU are also more likely to be readmitted to the hospital (Herrin, St. Andre, Kenward, Joshi, Audet, & Hines, 2015). In addition, the general surgical patient who had a preoperative open wound were at risk for readmission within 30 days of discharge ($p<.05$) (Kassin, Owens, Perez, Leeds, Cox, Schnier…Sweeny, 2012). These data suggest that decreasing PU development and promoting PU healing may also assist hospitals to decrease their overall 30-day readmission rates.

Identifying patients at risk for PU and communicating this risk to health care providers is a challenge in today’s healthcare environment (Alexander & Madsen, 2009; (Gregory L. Alexander & Madsen, 2012); Alexander, Pasupathy, Steege, Strecker, & Carley, 2014; Fossum, Alexander, Ehnfors, & Erenberg, 2011). Presently, the Braden Risk Assessment Scale (BRAS) is the most commonly used tool in the U.S. for PU risk assessment (Cooper, 2013). BRAS risk assessments are completed at specified times as determined by the health care agency; typically on admission, after a change in patient condition, and once or twice daily. Between these time points, however, opportunities are lost for identification of risk status changes and implementation of additional PU prevention strategies. Additional limitations of the BRAS are its subjective nature, inability to easily incorporate quantitative, physiologic PU risk factors, (Wound Ostomy and Continence Nurses Society, 2010), and its relatively weak predictive ability—especially in critically ill adults (Chou, Dana, Bougatsos, Blazina, Starmer, Reitel, & Buckley, 2013). Furthermore, many other physiologic PU risk factors not included in the BRAS have been identified (García-Fernández et al., 2014a). Currently, there is no
simple way for the bedside nurse to gather information on all these risk factors and interpret a patient’s true PU risk.

Some hospitals have started utilizing an early warning system integrated into the electronic health record (EHR) to monitor for changes in health status over time, alert health care providers to changes in a patient’s condition, and help prevent potential untoward events such as postoperative complications, unplanned medical or surgical intensive care unit readmission, in hospital death, or unplanned hospital readmissions (Bradley, Yakusheva, Horwitz, Sipsma, & Fletcher, 2013; Finlay, Rothman, & Smith, 2014; Gotur & Zimmerman, 2016; Piper, Kaplan, Maung, Lui, Barre, & Davis 2014; Rothman, Rothman, & Beals, 2013a; Tepas, Rimar, Hsiao, & Nussbaum, 2013). Identification of clinical deterioration early in the hospitalization allows for escalation of clinical care provided to limit untoward events (Sankey, McAvay, Siner, Barsky, & Chaudhry, 2016). The Rothman Index (RI) is an example of an early warning system that has been integrated into major EHR vendors such as Epic, Cerner, Eclipses Allscripts, McKesson Paragon, Siemens Soarian, Meditech, and Phillips International (ParaHealth, 2016). An early warning system, such as the RI, also may be a useful tool to aggregate additional PU risk factors not addressed by the BRAS and present them in a way to enhance communication among nurses and other healthcare providers (Berner, 2012). However, the relationship between the BRAS, the RI and pressure ulcer status has not been examined in the general medical-surgical patient population. Therefore, the purposes of this study were threefold: 1) to examine the relationship between the BRAS risk score and RI risk score in adult medical-surgical patients at discharge, 2) to compare BRAS risk scores, length of stay, rapid response episodes, RI risk scores, and 30 day
readmission rates in adult medical-surgical patients discharged with and without a PU, and 3) to examine the relationship between the presence or absence of a PU at discharge with BRAS risk categories, RI risk categories, rapid response episodes, and nursing staff reviews of the RI information in adult medical-surgical patients readmitted within 30 days of hospital discharge.

**Methods**

**Design**

This study was a retrospective, secondary data analysis from prior, unpublished research (Phillips et al., 2016) and employed a descriptive, correlational design using a limited data set from the EHR of a rural, Midwestern, not-for-profit, community hospital. The data were acquired from three distinct time periods: January 1, 2012-July 31, 2012; September 1, 2012-February 29, 2013; and March 1, 2013-August 31, 2013. The time periods were determined by the primary study and coincided with an evaluation of the impact of staff nurse education and training on the use of the RI. The first time period addressed staff nurse use of the RI after initial RI education. The second time period corresponded to staff nurse re-education on use of the RI, and the third time frame examined the sustainability of the staff nurse education provided. The education was planned to monitor and influence the increased use of the RI. Approval for the study was obtained from the Blessing Rieman College of Nursing and Allied Health and the University of Missouri’s Health Sciences Institutional Review Board.

**Setting and Sample**

The setting was a medical and surgical unit in a rural, Midwestern, not-for-profit, community hospital that used Eclipses Allscripts EHR, the BRAS, and the RI. Both the
medical and surgical unit had a 40-patient bed capacity. The average daily census on the medical unit was 31 patients a day, while the surgical unit average daily census was 33 patients per day during the time periods of the study.

Data were obtained from a limited data set acquired from the EHR. The sample included hospitalized adult patients who were greater than 18 years old and a patient on the medical or surgical unit during the time frame of interest. Exclusion criteria were patients hospitalized for observation or patients that did not have a BRAS or RI score recorded during the study period.

**Instruments and Variables**

**Braden Risk Assessment Scale.** The BRAS was used to determine PU risk. The BRAS has six subscales: sensory perception, moisture, activity, mobility, nutrition, and friction and shear. The total score ranges from 6 to 23 with lower scores indicating higher risk of PU. The BRAS was developed for use in the long-term care setting, although validity and reliability have been established in a variety of healthcare settings (García-Fernández, Pancorbo-Hidalgo, & Agreda, 2014; Pancorbo-Hidalgo, García-Fernandez, Lopez-Medina, & Alvarez-Nieto, 2006; Serpa, Santos, Campanili, & Queiroz, 2011). The BRAS reported sensitivity ranges from 83%-100% with specificity varying from 64%-90% and an interrater reliability of 0.99 for registered nurses (Bergstrom, Braden, Laguzza, & Holman, 1987; Bergstrom, Demuth, & Braden, 1987; Bergstrom, Braden, Kemp, Champagne, & Ruby, 1996).

For this study, the BRAS score at discharge was utilized as the variable of interest. BRAS scores were intended to be categorized as: No Risk (19-23), Mild Risk (15-18), Moderate Risk (13-14), High Risk (10-12) and Very High Risk (≤ 9) (Wound
Ostomy and Continence Nurses Society, 2010). Due to small frequency counts in the risk categories, the BRAS No Risk and Mild Risk categories were collapsed into one Low Risk category (15-23); High Risk and Very High Risk were also collapsed into a Highest Risk category (6-12). Thus, the three BRAS Risk categories used for the purposes of analysis were: Low Risk (15-23), Moderate Risk (13-14), and Highest Risk (6-12).

**Rothman Index.** The Rothman Index (RI) is an early warning system designed by data analysts to assist healthcare providers identify changes in a patient’s clinical condition over time including early detection of impending, in-hospital mortality, and to predict discharge readiness and care needed after discharge. Uniquely different from other early warning systems, the RI uses 26 variables (see Figure 4.1) falling into three general categories (vital signs, ongoing nursing assessments (including the Braden Scale and cardiac rhythms) and laboratory tests) which are captured from the EHR (Finlay et al., 2014; M. Rothman, Rothman, & Beals, 2013a; Rothman, Solinger, Rothman, & Finlay, 2012; S. Rothman, Rothman, & Solinger, 2013b). Within the RI, seven laboratory tests are included (see Figure 4.1) and results decline in importance within 24 hours of being drawn and do not impact the overall RI score after two days. Within the RI algorithm excess risk, defined as “percent absolute increase in 1-year mortality relative to minimum 1-year mortality identified for that variable” (M. Rothman et al., 2013a, p. 838), for each of the 26 variables is computed and, ultimately, cumulative risk is determined on a linear scale (Finlay et al., 2014). In the medical-surgical patient population, the RI score ranges from a low of 0 to a high of 100 (optimal score); however, in the case of a critically ill patient, the RI score may be as low as -91 (Bradley et al., 2013). A lower total score indicates higher acuity (Finlay et al., 2014); a
decreasing score suggests clinical deterioration and increased risk for adverse events (Bradley et al., 2013; Gotur & Zimmerman, 2016; Piper et al., 2014; Tepas et al., 2013). With color-coded alerts and trend lines, the RI informs health care providers of changes in condition over time (M. Rothman et al., 2013a).

A statistical analysis (1 - excess risk) was used to validate mortality within one month of discharge (S. Rothman et al., 2013b). Construct validity of the RI has been documented using the area under the curve (AUC) for the receiver operating characteristic curve; AUC was less than or equal to 0.62 for 30-day readmissions, greater than or equal to 0.93 for 24-hour mortality, and greater than or equal to 0.92 for differentiating discharge disposition (M. Rothman et al., 2013a). Additionally, the RI has been found to be superior to the Modified Early Warning System (MEWS) score based on respiratory rate, heart rate, systolic blood pressure, temperature, level of conscious, hourly urine output (Mathukia, Fan, Vadak, Biege, & Krishnamurthy, 2015) in predicting 24-hour mortality in adult, medical-surgical patients (Finlay et al., 2014).

The ongoing nursing assessment data are derived from the head to toe assessment data which evaluates physiologic system parameters (see Figure 4.1) Assessments are incorporated into the algorithm from the EHR using the binary code of “Met” or “Not Met” based on whether the documented assessment meets minimum accepted standards for each physiologic system parameter (M. Rothman et al., 2012). For example, the nursing assessment standard for the Skin/Tissue parameter is “Met” if documentation in the EHR includes: “Skin clean, dry and intact, with no reddened areas. Patient is alert, cooperative, and able to position self independently. Braden > 15.” (S. Rothman et al., 2013B, p.3). If the standard is not met, a series of questions are prompted to identify the
skin alteration (M. Rothman et al., 2012). The validity of using ongoing nursing assessments in a binary manner has been demonstrated by strong, positive correlations with both in-hospital and post-discharge mortality (Rothman et al., 2012).

RI scores at the rural Midwestern hospital were categorized as follows: Low Risk (65-100), Moderate Risk (40-64), High Risk (31-40) and Very High Risk < 30 (A. Loos, Education Services Instructor, personal communication, January 2016). Similar to the BRAS, due to small frequencies, RI High Risk and RI Very High Risk were collapsed into a Highest Risk category (≤40). Thus, the three RI Risk categories utilized for data analysis were: Low Risk (65-100), Moderate Risk (40-64), and Highest Risk (≤40). The BRAS and RI inputs are compared in Table 4.1.

Other Variables

Additional variables of interest were age at admission, hospital unit (medical or surgical), discharge diagnosis of a PU, stage of PU at discharge (Stotts et al., 2012), hospital length of stay, if the patient experienced a rapid response episode, the number of times nurses reviewed the RI information for a patient, and if the patient was readmitted within 30 days of discharge.

Data Collection

Data were compiled by the hospital’s Health Information Management (HIM) department personnel. The HIM department’s personnel built and verified accuracy of the computer program to collect relevant data. HIM department personnel conducted a pilot test of the computer program under the direction of the HIM Director.

The limited data set consisted of the following patient variables: length of stay in days; case mix index; all discharge diagnoses; discharge disposition; re-admission within
30 days from discharge; number of rapid responses team calls; RI 48 hours prior to patient death in hospital; RI score at discharge; number of times nursing reviewed the RI information for a patient; BRAS at discharge; visit date; and discharge date. International Classification of Diseases and health-related problems (ICD-9) were utilized to identify patients with pressure ulcers. Codes included: 707.20 for unspecified state; 707.21 as a Stage 1 PU; 707.22 as a Stage 2 PU; 707.23 as a Stage 3 PU; 707.24 as a Stage 4 PU and 707.25 as an Unstageable pressure or deep tissue injury (Hart, 2013).

**Data Analysis**

Data were cleaned and analyzed using the IBM Statistical Package for the Social Sciences (SPSS) Version 22 (Chicago, Il.). Data were assessed and cleaned to remove duplicate entries and erroneous values (e.g. if BRAS score of 4 recorded when range is 6-23). Characteristics of patients discharged with and without a PU were compared using t-tests for continuous variables and Chi square or Fischer’s Exact tests for categorical variables. PU period prevalence was calculated using the standard formula (National Pressure Ulcer Panel Advisory Panel, 2012) found in Appendix H. Spearman’s rho correlation was utilized to examine the relationship between the BRAS and RI at discharge. The number of RI scores available at discharge were 6,614 while available BRAS scores on the day of discharge were 6291. Pairwise analyses were used to address missing data. Only when both a RI and BRAS score were present, were calculations were completed. For patients readmitted within 30 days of hospital discharge, associations between categorical outcomes of interest were determined using Chi-square, Fischer’s Exact, or Cochran-Mantel-Haenszel Statistic. Level of significance was p<.05.
Results

A total of 7,567 unique patient discharges were included in this study. Of these, 3,952 (52.2%) were from the surgical unit and 3,615 (47.8%) were from the medical unit. The numbers of unique patient discharges by time period were: 2922/7567 (38.6%) January 1, 2012-July 31, 2012, 2311/7567 (30.6%) September 1, 2012-February 29, 2013, and 2334/7567 (30.8%) March 1, 2013- August 31, 2013. The typical participant was a 65 year old patient on the surgical unit, with a hospital stay between four and five days, categorized as Low Risk by both the BRAS and the RI at discharge, and was discharged without a PU.

Pressure Ulcer Prevalence

A total of 306 patients had a least one PU on discharge; 7/306 (2.3%) were hospital-acquired pressure ulcers (HAPU), 299/306 (97.7%) were present on admission. All HAPU were Stage 2 at discharge. Due to the low frequency of HAPU, all remaining analyses were performed based on the period prevalence of PU at discharge.

The overall PU period prevalence, regardless of ulcer severity, at discharge was 4.0% (306/7567). Period prevalence varied by ulcer severity with Stages 2-4 being most common: Stage 1(22/7567, 0.3%), Stage 2 (96/7567, 1.3 %), Stage 3 (74/7567, 1.0%), Stage 4 (85/7567, 1.1%), and unstageable/deep tissue injury (29/7576, 0.4%). The majority of patients with a PU (93% [286/306]) were age 50 years and older. The age group with the highest number of PUs (29% [90/306]) was in the 80-89 year range. Patients discharged with a PU had an average length of stay three days longer than those discharged without a PU ($t=-9.3, p<.001, 95\% CI$ for differences in means $[-3.593, -2.335]$). See Table 4.2 for characteristics of patients discharged with and without PU.
Braden Risk Assessment Score (BRAS) and Rothman Index (RI)

Overall, there was a strong positive linear relationship between the BRAS score and the RI score upon discharge in adult medical-surgical patients, regardless of PU status ($r_s = 0.771, p < .001$). Mean BRAS and RI scores were significantly different for patients discharged with and without a PU ($t=24.317, p<.001$ and $t=21.119, p<.001$, respectively; Table 4.2). On average, patients discharged with a PU were identified as Moderate and Highest Risk by the BRAS and the RI, respectively (Table 4.2). When examined by BRAS risk categories, patients discharged without a PU were almost exclusively categorized as Low Risk by the BRAS (90.8% [5457/6012]) with only a small proportion categorized as Moderate (4.4% [268/6012]) or Highest Risk (4.8% [287/6012]). Patients discharged with a PU were distributed across all three BRAS risk categories and, surprisingly, the majority of patients discharged with a PU were identified as Low Risk (52.3% [146/279]), followed by similar percentages at Moderate (23.3% [65/279]) and Highest Risk (24.4% [68/279]). In contrast, when examined by RI categories, only a small percentage of patients discharged with a PU were categorized as Low Risk (1.4% [4/286]) or Moderate Risk (9.4% [27/286]); and the vast majority were categorized as Highest Risk (89.2% [255/286]).

Rapid Response Episodes

Overall, 2.2% (169/7567) of adult medical-surgical patients experienced a rapid response episode during their hospitalization. The mean RI score at discharge, regardless of PU status, was lower for patients who experienced a rapid response episode (57.4±24.5) than for those who did not experience a rapid response episode (71.0±17.6) ($t= 7.129, p<.001$, 95% CI for differences in means [9.798, 17.300]). Being discharged
with a PU was associated with experiencing at least one rapid response episode during the hospitalization (Fischer’s exact test, $p < .02$). Specifically, the frequency of patients experiencing a rapid response episode was two times greater for those discharged with a PU (4.9% [14/287]) compared to those discharged without a PU (2.4% [155/6346]).

30 Day Hospital Readmission

Overall, the hospital readmission rate was 8.3% (629/7567). The mean RI score at discharge, regardless of PU status, was lower for patients readmitted within 30 days (64.0±20.5) than for those not readmitted (71.3±17.4) ($t = 8.633$, $p < .001$, 95% CI for differences in means [5.651, 8.978]). When examined by PU status at discharge, readmission rates were significantly higher for patients discharged with a PU compared to those without a PU (Fischer’s exact test, $p < .001$; Figure 4.1). Experiencing a rapid response episode during the hospitalization, however, was not associated with hospital readmission within 30 days (Fischer’s exact test $p = .589$).

When examined by BRAS risk categories, readmission within 30 days of hospital discharge was associated with PU status (Chi-square, $p < .001$). For patients readmitted within 30 days who were discharged without a PU, 83.9% (480/572) were identified in the BRAS Low Risk category. In contrast, patients readmitted within 30 days that were discharged with a PU, were distributed across the three BRAS risk categories: Low Risk (47.3% [26/55]), Moderate Risk (20% [11/55]), Highest Risk (32.7% [18/55]).

When examined by RI risk categories, readmission within 30 days of hospital discharge also was associated with PU status (Chi-square, $p < .001$). Patients readmitted within 30 days that were discharged without a PU were distributed across the three RI risk categories: Low Risk (27.1% [155/573]), Moderate Risk (22.3% [128/573]), Highest
Risk (50.6% [290/573]). In contrast, 89.1% (49/55) of patients readmitted within 30 days who were discharged with a PU, were in the RI Highest Risk category. Additionally, among patients readmitted within 30 days, nurses reviewed the patient’s RI information in the EHR more often in those discharged with a PU (16.4±11.2) than those discharged without a PU (10.8±11.4) ($t= -3.453, p<.001$, 95% CI for differences in means [-8.694, -2.390]). However, when normalized by hospital length of stay (Appendix H), there was no statistically difference in the average number of times the nurses reviewed the RI information in the EHR for those discharged with a PU (2.7 ±1.5) than those discharged without a PU (2.2 ±1.7) ($t=-1.842, p=0.07$, 95% CI for differences in means [-0.899, 0.029]).

**Discussion**

This study identified four key findings. First, the BRAS risk score at discharge was strongly and positively correlated with the RI risk score at discharge, regardless of the PU status. Second, when examined by PU status at discharge, mean BRAS and mean RI categorized risk level similarly in adult, medical-surgical patients. However, when examined by BRAS and RI risk categories at discharge, the majority of patients discharged with a PU were identified as Low Risk by the BRAS but as Highest Risk by the RI. Third, readmission within 30 days of hospital discharge was associated with PU status at discharge. Lastly, the presence of a PU at discharge was associated with a longer length of stay, greater frequency of rapid response episodes, and a higher 30 day readmission rate.

**Braden Risk Assessment Score, Rothman Index and Pressure Ulcer Status**
To our knowledge, this is the first study to examine the relationship between the BRAS, RI and PU status at discharge. The RI includes physiological parameters that are not quantitatively evaluated by the BRAS. The addition of quantifiable, physiologic risk factors in a pressure ulcer risk assessment tool is not a new concept and has been supported by other researchers (Cox, 2013; Cox & Roche, 2015; García-Fernández, Agreda, et al., 2014; Man & Au-Yeung, 2013). An advantage of the RI is its ability to automatically update and quantify changes in physiological factors in real-time – many of which are known to increase PU risk. Due to the retrospective study design and low incidence of HAPU, we were not able to examine validity of the RI for PU prediction. Given the strong, positive correlation between the BRAS and RI risk scores found in this study, future prospective studies need to compare the predictive validity of BRAS and RI for assessing PU risk in adult medical-surgical patients.

On average, both the BRAS and RI were able to differentiate risk level in patients discharged with and without a PU (Table 4.2). However, when examined by risk categories, over half the patients discharged with a PU were categorized as Low Risk by the BRAS. By definition, a patient that has one PU is at a higher risk to develop another PU than a patient who does not have a PU (Wound Ostomy and Continence Nurses Society, 2010). Thus, the BRAS appears to have underestimated PU risk post-hospitalization. Categorizing a patient with a PU as BRAS Low Risk at discharge, may limit their ability to get necessary post-discharge resources such as support surfaces, home health care, or skin/wound care supplies. It is unclear from this study whether this underestimation of risk was due to staff nurses’ inaccurate completion of the BRAS on the day of discharge or whether this is a weakness of the BRAS tool itself. In contrast,
the RI placed the vast majority of patients discharged with a PU in the Highest Risk category. Thus, the RI may be a useful tool to help capture post-discharge needs in patients with PU.

**Adverse Events Associated with Pressure Ulcer Presence at Discharge**

**Length of Stay.** The presence of a PU at discharge was associated with increased hospital length of stay, which is consistent with prior research (Graves, Birrell, & Whitby, 2005; Lyder et al., 2012; Russo, Steiner, & Spector, 2008). Similar to the work done by Graves and colleagues (2005), the length of stay in our study was extended 3 to 4 days longer for patients with a PU. In contrast, two other studies found the length of stay to be for 6 to 7 days longer than those without a PU (Lyder et al., 2012; Russo et al., 2008). These findings may vary due to differences in the patient characteristics. For example, the sample in the study by Lyder and colleagues (2012) consisted of Medicare patients with a mean age of 73 years, whereas our sample included adult patients ranging from 18-88 years of age with a mean of 65 years. Older, Medicare patients may have additional co-morbid conditions that contribute to a longer length of stay. In addition to patient characteristics, other factors not examined by this study such as nursing education, expertise, and workload may explain the differences in length of stay (Aiken, Clarke, Sloane, Sochalski, & Silber, 2002; Aydin, Donaldson, Stotts, Fridman, & Brown, 2015).

To minimize the extended length of stay associated with the presence of a PU, nurses must initiate prevention and treatment strategies as soon possible in patients with a PU. During the admission process, a PU bundle should be initiated. The PU bundle may include a pressure redistribution mattress, transfer slide, turning protocol poster, wound
measurement tools, as well as skin and wound care supplies (Anderson, Finch, Kraft, Reicks, Skay, & Beal, 2015; Coyer, Gardner, Doubrovsky, Cole, Ryan, Allen & McNamara, 2015). A specific turning schedule and nutritional supplement alerts could be activated in the EHR to remind care providers. Additionally, staff nurse assignments may need adjustment since patients with a PU typically require higher levels of nursing care due to the patient’s need for nutrition, hydration, mobility, and positioning interventions, as well as the required wound healing treatment modalities (Aydin et al., 2015). Addressing the needs of the patient admitted with a PU early and throughout their hospital stay, will not only have a positive impact on PU status, but may also decrease hospital length of stay.

**Rapid Response Episodes.** From a pathophysiologic perspective, it would make sense that patients who experience one or more rapid response episodes would be more likely to develop a PU due to hemodynamic instability resulting in altered oxygenation and perfusion of the tissues and shunting of blood to the body’s core for survival (Bly, Schallon, Sona, & Klinkenberg, 2016; Cox, 2013; Cox & Roche, 2015; Man & Au-Yeung, 2013). However, in this study, that was not the case because approximately 97% of the patients discharged with a PU had the ulcer present on admission. Thus, these data suggest that adult medical-surgical patients with a PU may be at higher risk for clinical deterioration than those without a PU. Early warning systems, such as the RI, may be useful to assist healthcare providers to identify clinical deterioration and worsening physiologic dysfunction early so as to prevent unplanned admission to the medical or surgical intensive care unit and improve cost-efficiency of care (Capan, Ivy, Rohleder, Hickman, & Huddleston, 2015; Gotur & Zimmerman, 2016; Piper et al., 2014; Tepas et
al., 2013). To be clinically useful, however, clinicians need to regularly review the RI data for their patients and then take actions when trends change (Yale-New Haven Hospital, 2013). Our data suggest that, on average, nurses only reviewed the RI information two to three times per day which may be inadequate to capture subtle changes in the patient’s condition. An idea to facilitate reviews of the RI could include a nursing policy change to review the RI when assessing vital signs in addition to charting times. A potential limitation of the RI at present is that the healthcare provider must log into the EHR and click on the RI tab to reveal the results. For ease of access, the RI could be designed to send a message to the nurse’s phone via a text alert relaying a significant change in status, or a sudden drop in the RI. The RI could also be designed to open automatically when retrieving each patient record, offering the healthcare provider immediate and ongoing access.

**Readmission within 30 Days of Hospital Discharge.** Similar to prior PU research, (Bogaisky & Dezieck, 2015; Herrin et al., 2015; Lyder et al., 2012; Nguyen et al., 2016; Piper et al., 2014), we found PU presence at discharge to be associated with a higher rate of unplanned readmission within 30 days of discharge. Additionally, this data are consistent with prior RI research for patients at risk for unplanned readmission. Specifically, patients discharged with a PU who were readmitted within 30 days of discharge had a mean RI score less than 50 which falls within the highest risk RI category for unplanned hospital readmissions (Bradley et al., 2013). Indeed, in our study, the mean RI score of the patients with a PU at discharge (46.9) was similar to the reported RI scores associated with unplanned readmission to the medical or surgical intensive care unit in prior studies (Gotur & Zimmerman, 2016; Piper et al., 2014).
These data suggest that PU presence at discharge increases the risk for unplanned hospital readmission within 30 days of discharge. The RI may be a useful adjunct to clinical judgement to assist healthcare providers to more accurately identify discharge readiness, prevent unplanned hospital readmission and/or determine optimal discharge placement (Bradley et al., 2013). From the hospital’s perspective, careful care coordination should be provided prior to and after discharge. For example, if a patient has a PU and a low RI score (high RI risk category), transfer to a long term acute care facility or inpatient rehabilitation unit may be more appropriate than discharge to home or a skilled nursing facility. Suggested services and resources that may be needed to enhance PU healing and mitigate hospital readmission include availability of a Wound Ostomy Continence nurse, provision of nutritional support, appropriate nurse/patient staffing, physical therapy for mobility, and an appropriate support surface for the bed and/or chair (Cooper, Vellodi, Stansby, & Avital, 2015; Wound Ostomy and Continence Nurses Society, 2010). Another direction for future research would be to explore whether RI scores can be useful for identifying the appropriate discharge disposition for adult medical-surgical patients discharged with and without a PU.

While PU presence at discharge was associated with readmission within 30 days of discharge, having had a rapid response episode during the hospitalization was not associated with readmission. These data suggest that PU presence at discharge may be a better indicator of frailty than a clinical deterioration experience (e.g. rapid response episode). Frailty has been defined in many ways in the literature, but one definition particularly relevant to this study is “a state of increased vulnerability to adverse outcomes” (Searle, Mitnitski, Gahbauer, Gill, & Rockwood, 2008). Indeed, one recent
study utilized the BRAS as a proxy measure for frailty risk and found that frailty risk and
type of admission (medical vs. surgical) impacted rapid response team activation but
having a previous clinical deterioration event did not (Capan et al., 2015). Use of the RI
may assist in identification of patients at risk for adverse events, guide healthcare
providers in the personalization of the patient’s healthcare experience and improve
healthcare outcomes.

**Limitations**

The limitations of this study need to be acknowledged. This study utilized a
retrospective design with a single center cohort. As with all retrospective studies
utilizing documentation within the EHR, the findings are limited by the accuracy and
completeness of the documentation. Future prospective, multi-center studies are needed
to validate the findings and increase the generalizability. Due to the variables available
in the limited data set, we were unable to account for impact of patient-related
socioeconomic factors (e.g. gender, education, employment, social support) and staffing
related factors (e.g. nursing education, expertise, workload) which may have impacted
length of stay and readmission rates. Since we were unable to account for readmissions
that occurred at another hospital, actual readmission rates may be higher; however, due to
the rural location of the study site, readmission to another hospital is unlikely.

**Conclusion**

Quality patient care is integral in today’s healthcare. Pressure ulcers, an
important indicator of healthcare quality, are a financial burden, particularly in light of
their relationship to increased risk of adverse events such as increased length of stay,
elevated acuity from a rapid response episode and unplanned readmission within 30 days
of discharge. In response to the findings from this study, healthcare providers and healthcare agencies must realize that when a patient is admitted with a PU, aggressive care strategies and education are needed to facilitate PU healing and to decrease hospital length of stay. By displaying information in real-time, an early warning system, such as the RI, may assist with more accurate and timely identification of patient risk and, thereby, allow healthcare providers to implement strategies to forgo untoward conditions and avoid adverse events. Furthermore, information technology also may facilitate care coordination and foster more appropriate discharge placement decisions, thus, preventing unplanned hospital readmission within 30 days after discharge.
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Figure 4.1 Rothman Index variables and relative contributions for each category of variables.

Table 4.1

Comparison of the BRAS and RI Risk Factors

<table>
<thead>
<tr>
<th>Factor</th>
<th>Braden Risk Assessment Score (BRAS)</th>
<th>Rothman Index (RI)</th>
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<tbody>
<tr>
<td><strong>Pressure</strong></td>
<td></td>
<td></td>
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<tr>
<td>Mobility</td>
<td>Mobility subscale</td>
<td></td>
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<tr>
<td>Activity</td>
<td>Activity subscale</td>
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<td>Sensory Perception</td>
<td>Sensory perception subscale</td>
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<tr>
<td><strong>Tissue Tolerance</strong></td>
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<tr>
<td><strong>Extrinsic Factors</strong></td>
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<td>Moisture</td>
<td>Moisture subscale</td>
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<td>Friction and Shear</td>
<td>Friction and Shear subscale</td>
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<tr>
<td><strong>Intrinsic Factors</strong></td>
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<tr>
<td>Nutrition/Hydration</td>
<td>Nutrition subscale</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>Advanced age moves Braden’s risk to higher risk category</td>
<td>Nursing Assessments: Cardiac, Peripheral-vascular, Skin</td>
</tr>
<tr>
<td>Arteriolar pressure</td>
<td>Left to nurse’s clinical judgment</td>
<td></td>
</tr>
<tr>
<td><strong>Hypothetical Factors Referenced in Braden’s Conceptual Schema</strong></td>
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<td></td>
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<tr>
<td>Interstitial fluid flow</td>
<td>Left to nurse’s clinical judgment</td>
<td>Nursing Assessments: Cardiac, Skin</td>
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<tr>
<td>Emotional stress</td>
<td>Left to nurse’s clinical judgment</td>
<td>Nursing Assessments: Neurological, Psychological</td>
</tr>
<tr>
<td>Smoking</td>
<td>Left to nurse’s clinical judgment</td>
<td>Nursing Assessments: Respiratory, SaO2, R</td>
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<tr>
<td>Skin temperature</td>
<td>Left to nurse’s clinical judgment</td>
<td>Nursing Assessments: T</td>
</tr>
</tbody>
</table>

Note. Adapted from Braden Risk Assessment Scale (Braden & Bergstrom, 1987) and the Rothman Index (M. Rothman et al., 2013a). BUN = Blood Urea Nitrogen, Cl = Chloride, Cr = Creatinine, K = Potassium, Na = Sodium, Hgb = Hemoglobin, WBC = White Blood Cell Count, DBP = Diastolic Blood Pressure, SBP = Systolic Blood Pressure, P = Pulse, SaO2 = Pulse Oximetry, R = Respiratory Rate, T = Temperature.
Table 4.2

Mean (±SD) Patient Characteristics at Discharge.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>All Patients (N=7567)</th>
<th>Pressure Ulcer (N=306)</th>
<th>No Pressure Ulcer (N=7261)</th>
<th>P-Value</th>
<th>95% CI For differences in means</th>
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</thead>
<tbody>
<tr>
<td>Age</td>
<td>65.0 (±15.8)</td>
<td>66.6 (±14.1)</td>
<td>65.0 (±15.9)</td>
<td>&lt;.01</td>
<td>(-3.24, 0.00)</td>
</tr>
<tr>
<td>Length of Stay</td>
<td>4.4 (±3.8)</td>
<td>7.3 (±5.5)</td>
<td>4.3 (±3.7)</td>
<td>&lt;.001</td>
<td>(-3.59, -2.33)</td>
</tr>
<tr>
<td>BRAS Risk Score</td>
<td>18.7 (±3.1)</td>
<td>14.5 (±2.8)</td>
<td>18.9 (±2.9)</td>
<td>&lt;.001</td>
<td>(4.00, 4.71)</td>
</tr>
<tr>
<td>RI Risk Score</td>
<td>70.6 (±17.9)</td>
<td>49.5 (±16.8)</td>
<td>71.6 (±17.3)</td>
<td>&lt;.001</td>
<td>(20.01, 24.16)</td>
</tr>
</tbody>
</table>

Note. CI = confidence interval, SD = standard deviation, N = Number, RI = Rothman Index.
Figure 4.2. Frequency of Adverse Events in Hospitalized Adult Medical Surgical Patients

Data are presented as a frequency/rate. Gray shaded bars are PU presence at discharge. White unfilled bars are PU absence at discharge. Sample sizes are indicated in parentheses. Statistically significant differences in the readmission rate with PU Presence at Discharge > readmission rate with PU Absence at Discharge $p<.001$; statistically significant differences in the occurrence of at least one rapid response episode with PU Presence at Discharge $> $ rapid response episode occurrence with PU Absence at Discharge $p<.02$. 

*Frequency of Adverse Events in Hospitalized Adult Medical Surgical Patients.*
CHAPTER FIVE:  
CONCLUSION  
Overview of Dissertation Preparation

Given my background as a certified Wound, Ostomy Continence Nurse, the phenomenon of interest for doctoral work was pressure ulcer prediction and prevention. Along with the required doctoral course work in philosophical and theoretical perspectives, research ethics, methods, and practice; and statistical methods, dissertation preparation specific to my research interests included three courses in gerontology and three courses in information technology. Since the majority of individuals who develop a pressure ulcer are older adults, gerontology course work was planned to enhance knowledge related to the specific alterations and needs of individuals as they age. The gerontology courses focused on physiology of aging, qualitative research methods in the elder population, and a research practicum with Dr. Gregory Alexander focused on pressure ulcer prevention and communication in the long term care setting. The outcomes of the gerontology course work included a group paper on osteoporosis, a qualitative research proposal on nurses perceived needs and care of hospitalized patients with pressure ulcers, poster presentations at local, regional and national meetings and a first authored, data-based, article published with Drs. Gregory Alexander and Deidre Wipke-Tevis (Shepherd, Wipke-Tevis, & Alexander, 2015). Additionally, upon completion of the doctoral degree, this coursework meets the requirements for a Graduate Minor in Gerontology.

Information technology preparation included two health informatics courses: 
*Introduction to Healthcare Information Technology* and *Clinical Decision Support Systems* with Drs. Win Phillips and Patricia Alafaireet, respectively. The third course was
a substantive nursing science course, *Technology Evaluation in Healthcare Systems Research*, co-taught by Drs. Gregory Alexander and Bonnie Wakefield which included an in-depth review of health information technology and data collection related to the state nurse association websites. The culmination of the information technology coursework included a multi-authored, data-based publication on the heuristic review of state nurses association websites (Alexander, Wakefield, Anbari, Lyons, Prentice, Shepherd, Strecker & Weston, 2014), development of a pre-proforma, workflow analysis and preparation of a request for proposal. The request for proposal, the final project, was the development of a real-time, pressure ulcer prevention clinical decision support system.

The final projects for each support course provided an excellent preparation for the dissertation process. Development of a qualitative research proposal, presentation of posters for professional conferences, preparing manuscripts for publication, heuristic analysis of information technology website tools, and designing a process to enhance health care and putting it into a request for proposal were all quite challenging, but also very rewarding. Honing the skills of proposal writing, manuscripts preparation, and dissemination of research findings are the key outcomes attained during doctoral studies. These are the skills I will use in my career and share with fellow faculty and students.

Summary and Synthesis of Findings

Assessment and evaluation of patients status is a priority in providing safe patient care. Providing an efficient and effective method of communication is vital in both acute and long-term care. Information technology has been purported to assist in providing communication enhancement in patient care (Alexander & Madsen, 2012; Alexander,
Pasupathy, Steege, Strecker, & Carley, 2014; Alexander, Steege, Pasupathy, & Wise, 2013). For example, recognition and communication of status changes can guide healthcare providers in clinical decisions to foster earlier implementation of evidenced based guidelines (Berner, 2012). Of specific interest to this dissertation, the use of information technology in healthcare settings may assist with early identification of pressure ulcer risk and communication of subtle changes associated with pressure ulcer development, increased length of stay, rapid response episodes, and hospital readmission within 30 days of discharge. Prevention of adverse events and unplanned hospital readmissions are quality measures in both acute and long term care and now a fiscal priority due to reimbursement changes (Centers for Medicare and Medicaid Services (CMS), HHS, 2011).

The first study, Analysis of Qualitative Interviews about the Impact of Information Technology on Pressure Ulcer Prevention Programs: Implications for Wound, Ostomy and Continence Nurses, compared the pressure ulcer prevention programs in one long-term care facility with high Information Technology Sophistication (ITS) and one long-term care facility with low ITS. A qualitative, secondary analysis of focus group interviews of direct and nondirect care providers revealed three major differences in communication strategies between the two long-term care facilities: education opportunities, electronic communication and documentation (information access), and PU prevention strategies. The high-ITS facility provided regularly occurring PU prevention education which was readily available to the direct care nursing staff. Likewise, in the high-ITS facility, the staff had superior access to resident-specific health information at the bedside and was able to document PU prevention and treatment strategies in the EHR.
Moreover, the high-ITS facility utilized a wide variety of PU prevention communication strategies such as computer access at the bedside, easily accessible evidence-based protocols, and visual cues for implementation of PU prevention strategies for the direct care provider. In summary, these findings suggested that information technology is an important component of a PU prevention program in the long-term care setting.

The second study, *Rothman Index as a Predictor of Rapid Response Episode Occurrence, Pressure Ulcer Status at Discharge and Hospital Readmission in Adult Medical-Surgical Patients*, utilized a limited data set from the EHR of a rural, Midwestern, not-for-profit, community hospital. The study was a retrospective secondary data analysis that explored whether the Rothman Index (RI) would be useful for the prediction of pressure ulcer risk, pressure ulcer status at discharge, rapid response episode occurrence, and unplanned hospital readmission within 30 days in adult medical-surgical patients. Utilizing a descriptive, correlational design, we determined that the Braden Risk Assessment Scale (BRAS) and RI risk scores were strongly and positively correlated at discharge. Interestingly, the majority of patients discharged with a PU were identified as Low Risk by the BRAS but as Highest Risk by the RI. Moreover, PU presence at discharge was associated with a longer length of stay, greater frequency of rapid response episodes, and a higher 30 day readmission rate. In summary, the findings from the second study suggested that the RI may be a useful adjunct for the identification of patients at risk for pressure ulcers and other adverse events, may better guide healthcare providers in the appropriate disposition of patients after hospital discharge, ultimately, may help improve healthcare outcomes by increasing communication within the healthcare team.
Patient safety is a key measure in quality care and information technology is a vital tool for the attainment of this goal. Both studies in this dissertation examined the use of information technology to determine its usefulness in communicating pressure ulcer risk, prevention, and status; however, one occurred in acute care and the other occurred in long term care. In the second study, however, the influence of information technology expanded beyond pressure ulcers to include additional relevant quality indicators; specifically, rapid response episode occurrence, length of stay, and unplanned hospital readmission. Although both studies were a retrospective analysis of secondary data, the research methods and analyses differed. One used qualitative data analysis while the other focused exclusively on quantitative methods and statistical analysis. Despite the differences in the study design, sample, setting, and analyses, both projects highlight the importance of information technology to improve access to patient-specific information, detect changes in patient status, facilitate communication among healthcare providers, and ideally, prevent adverse events.

Significance of the Dissertation Work

Healthcare is an ever changing environment regulated by State and Federal statutes. Investigation of methods by which communication is enhanced among healthcare providers is an essential aspect of adhering to these regulations. In this dissertation, two studies have highlighted the importance of communication and information technology as related to important quality indicators. This dissertation work is significant for a number of reasons. This dissertation is the first study that has utilized the RI to examine pressure ulcer status and the findings have raised some important questions related to the accuracy of BRAS scoring at discharge. Additionally, this is one
of the first studies using the RI in a rural hospital setting. Use of an early warning system such as the RI may be particularly useful in a more rural hospital where nursing staff ratios may be lower and nursing may have more of a generalist focus. Additionally, this study has highlighted that patients discharged with a PU are at greater risk for in-hospital complications as well as hospital readmission which may have implications for in-hospital staffing ratios and discharge planning. Lastly, since patients discharged with a PU had RI scores similar to those at risk for readmission to the medical or surgical intensive care unit (Gotur & Zimmerman, 2016; Piper et al., 2014), these findings also suggest that healthcare providers may not be using the RI as intended for appropriate discharge disposition decision-making. While no information technology tool could or should replace clinical judgement, the limited research suggests that an early warning system such as the RI may be useful in preventing unplanned hospital readmissions—but only if the healthcare providers utilize the information to make informed, data-based discharge planning decisions.

Challenges and Limitations

Knowing the data needed, this dissertation project International Review Board process was started early to assure data could and would be available. Preliminary approval was obtained from the Chief Nursing Officer and Chief Executive Officer of the facility from which data would be obtained. Over time and with personnel changes, particularly organizational leadership change, so did the prior approvals. The collection of data over time of multiple BRAS and RI scores was denied. Additionally, two research grants were written, one to the Wound, Ostomy, Continence Society and one to the MU Interdisciplinary Center on Aging, Research Enrichment and Dissemination
(READ) program. Had either of these grants been funded, the organization might have agreed to provide the staff hours to obtain the originally requested data. Fortunately access was granted to an existing limited dataset containing BRAS and RI scores at discharge. The next challenge then became revision of the specific aims and questions. Preliminary analysis of the limited data set then revealed an extremely low incidence of hospital-acquired pressure ulcers which required yet another revision of the specific aims and questions.

As a result of these aforementioned challenges, there are important limitations to this study. Firstly, this is only a single site study, which limits the generalizability of the findings. However, the results remain valuable as this was the first study using the RI in a rural hospital setting. Due to the parameters of the existing limited dataset, additional variables of interest relevant to pressure ulcer status (e.g. patient specific psychosocial variables and staff specific processes of care variables) were not available for inclusion in the analysis. Likewise, as with all retrospective studies, the dataset had some duplicate entries as well as erroneous and/or missing data elements. For example, the BRAS score was not always calculated by nursing staff on the day of discharge, whereas the RI was calculated automatically resulting in unequal sample sizes for the BRAS and RI elements. However, careful cleaning and pairwise analysis were used to overcome these problems and assure the assumptions of the statistical procedures were met.

Future Directions

This dissertation project, in particular, and my doctoral education, in general, has provided a strong foundation for continued work as a tenured faculty member at Blessing Rieman College of Nursing and Health Sciences. After obtaining the doctoral degree, I
will be eligible to mentor master’s student projects and thesis research. Additionally, as a member of Blessing Rieman College of Nursing and Health Sciences research committee, I will support, guide, and mentor fellow faculty in the research process. I will also assist nurses and other healthcare providers at the bedside integrate research concepts into their clinical practice, thus, promoting safe patient care and maintenance of Magnet status.

In the immediate future, my personal research trajectory will be to continue with the development of two additional manuscripts from my dissertation research. One manuscript planned is a systematic literature review related to the RI. The other future manuscript is a conceptual comparison of the BRAS and the RI. These two proposed manuscripts will fill important gaps in the current nursing literature.

The next steps that I anticipate will be to continue my work with the RI and the interrelationships between increased length of stay, rapid response occurrence, pressure ulcer development, and readmission within 30 days of hospital discharge. To gather additional information on pressure ulcer risk detection, a prospective, repeated measures study is needed using BRAS and RI scores throughout the patients’ hospitalization to compare predictive validity between the two tools. I am also interested in exploring what other adverse events are associated with PU development and what nursing interventions may help mitigate these events.
VITA

Marilyn Jean Murphy was born May 2, 1954 in Hannibal, Missouri to the parents of, Ralph and Jean Murphy. I lived in the rural village of East Hannibal, Illinois for the first 21 years of my life. I attended school in the small rural farming community of Pike County, Illinois. Our family lived along the Mississippi River providing commerce to the community with two small businesses and farm. I obtained my Associate Degree in Science at Hannibal LaGrange College and completed my Diploma in Nursing at Blessing Hospital’s Training School for Nurses in 1978. Bachelor’s degree in Nursing was completed at Quincy College and received my Masters in Maternal Child Health Nursing at the University of Missouri-Columbia. In 2016, I completed my Doctor of Philosophy. During my journey I have worked as a Pediatric nurse, staff educator, nurse manager, certified diabetic educator, wound ostomy continence nurse, and now academic instructor at the Blessing Rieman College of Nursing. I tribute my love of nursing to my mother, who provided care for our family, friends, and community.
Comprehensive Reference List


with high IT sophistication. *International Journal of Medical Informatics*, 83(8), 581–591. http://doi.org/10.1016/j.ijmedinf.2014.05.001


Centers for Medicare and Medicaid Services (CMS), HHS. (2014, August 22). Medicare program; hospital inpatient prospective payment systems for acute care hospitals and the long-term care hospital prospective payment system and fiscal year 2015 rates; quality reporting requirements for specific providers; reasonable compensation equivalents for physician services in excluded hospitals and certain teaching hospitals; provider


http://doi.org/10.4037/ajcc2015930


Fossum, M., Ehnfors, M., Svensson, E., Hansen, L. M., & Ehrenberg, A. (2013). Effects of a computerized decision support system on care planning for pressure ulcers and


http://doi.org/10.1016/j.chest.2016.02.155

http://doi.org/10.1086/502542


http://doi.org/10.1111/1475-6773.12177


The Journal of Trauma and Acute Care Surgery, 77(1), 78–82.  
http://doi.org/10.1097/TA.0000000000000265


http://doi.org/10.1136/bmjopen-2012-000849


http://doi.org/10.1001/jama.296.13.1645


APPENDIX A.
Permission letter from Copyright Clearance Center

Dear Marilyn,

Thank you for your recent phone call to the Copyright Clearance Center. As discussed, below is an example of the citation that Wolters Kluwer would like you to use when citing the article “Analysis of Qualitative Interviews About the Impact of Information Technology…” in your dissertation.

Below is a screenshot of the messaging provided in our RightsLink permissions form. This messaging states that this reuse is free of charge and no permission letter is needed from Wolters Kluwer.

Since you are looking to obtain a copy of your last submission for this article, please contact Wolters Kluwer directly at:

Gary Mawyer, Managing Editor,

jwocneditorial@gmail.com

If you have any additional questions or concerns, please do not hesitate to ask.
Sincerely,

Erika

Erika Bagley
Customer Account Specialist
Copyright Clearance Center
222 Rosewood Drive
Danvers, MA 01923 USA

+1.855.239.3415 (Opt. 1)

+1.978.646.8600 (Fax)
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www.copyright.com

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APPENDIX B
CITI Training Report

CITI Collaborative Institutional Training Initiative

HS Biomedical Group Curriculum Completion Report
Printed on 2/17/2013

Learner: Marilyn Shepherd (username: mshepherd@brcn.edu)
Institution: University of Missouri-Columbia
Contact Information: Hannibal, Mo 63401
Department: nursing
Phone: 573-248-9733
Email: mshepherd@brcn.edu

HS Biomedical Group:

Stage 2. Refresher Course Passed on 03/01/12 (Ref # 7578385)

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For this Completion Report to be valid, the learner listed above must be affiliated with a CITI participating institution. Falsified information and unauthorized use of the CITI course site is unethical, and may be considered scientific misconduct by your institution.

Paul Braunschweiger Ph.D.
Professor, University of Miami
Director Office of Research Education
CITI Course Coordinator

Return

https://www.citiprogram.org/members/learnersII/crbystage.asp?strKeyID=BA914E93-6CE... 2/17/2013
APPENDIX C.
IRB approval letter from the University of Missouri

Project number 2004071
Review ID Exempt Application: 209750
Project title Analysis of an Early Warning System to determine the Association with Pressure Ulcer Risk
Principal investigator Marilyn M Shepherd, Masters in Nursing
Primary contact Marilyn M Shepherd, Masters in Nursing; Deidre D Wipke Tevis

Hello Investigators,

Please click on the following link to view the IRB determination for the review noted above.

https://ecompliance.missouri.edu/my/irb/projects/53184/attached_files/293752

This letter was also saved to document storage for this study.

Thank you,

Project #2004071 Review #209750 Project Title: Analysis of an Early Warning System to determine the Association with Pressure Ulcer Risk Principal Investigator: Marilyn M Shepherd, Masters in Nursing Primary Contact: Marilyn M Shepherd, Masters in Nursing IRB Expiration Date: August 24, 2016

Your review above has been acknowledged. Reporting: Any item requiring reporting, including submitting the IRB approved supportive documents (consents, surveys, recruitment, etc.) or reporting changes to the study, will need to be submitted using the Misc. Reporting Form in eCompliance. Continuing Review: When the research receives continued IRB approval from the IRB of record, the approval letter must be
submitted using the IRB of Record Continuing Review form. A courtesy reminder will be sent from our office prior to the expiration date. Researcher Responsibilities:

1. The researchers will comply with the determinations and requirements of the reviewing IRB.

2. The researchers will provide the reviewing IRB with any local context issues relevant to the research protocol.

3. The researchers will inform MU IRB of all the reviewing IRB decisions and determinations.

4. The researchers will report any proposed changes, unanticipated problems, noncompliance, or protocol deviations to the reviewing IRB.

5. The researchers will provide to the reviewing and MU IRB any data safety monitoring reports received, either at continuing review, upon request by the IRB, or on an emergent basis.

6. When responsible for enrolling participants, the researchers will obtain, document, and maintain records of consent for each participant or LAR as stipulated by the reviewing IRB.

7. The researchers acknowledge they are primarily responsible for safeguarding the rights and welfare of each participant, and the participant's rights and welfare must take precedence over the goals and requirements of the research.

8. All records will be maintained per institutional policy.

Sincerely, MU Institutional Review Board 573.882.3181
Appendix D.
Blessing-Rieman College of Nursing Institutional Review Board Approval
Letter

Institutional Review Board

Broadway at 11th • PO Box 7005 • Quincy, Illinois 62305-7005 • 217-228-5520

July 30, 2015

Marilyn Shepherd, PhDc, RN, MBA
Blessing-Rieman College of Nursing
11th at Broadway
Quincy, IL 62301

Dear Ms. Shepherd,

The study, *Analysis of an Early Warning System to Determine the Association with Pressure Ulcer Risk*, was approved by the IRB on July 29, 2015 as an exempt review because the research design met the criteria for this type of review as outlined in the IRB’s policies and procedures and poses minimal to no risk to participants. The study was assigned the following IRB number: 2015-10.

The study meets all requirements for the protection of human subjects and their rights. Privacy and confidentiality with gathering, handling, storing, and analyzing data were adequately outlined in the proposal. In light of the research design poses minimal to no risk to participants, interim reports during the study are not needed. It was also determined that your study met the criteria under 45CFR 46.116(d) for waiver of consent. Because the study involved the use of patient records, the IRB also reviewed the study according to
criteria under 45CFR 164.512(i)(2)(ii) for waiver of HIPAA Authorization. See the accompanying letter regarding the use of patient data under HIPAA.

Please note that the IRB approved the study based on its proposed research design. Therefore, any change in this design (protocol) necessitates submitting a Change in Protocol form and another review by the IRB. If the study is not completed by the projected completion date of July 30, 2016, an extension of the study’s timeline must be requested by submitting the Timeline Extension form one month before the study’s timeline expires. Any adverse event that occurs during the study must immediately be reported to the IRB by submitting the Adverse Event form. All forms are on the Blessing Health Professions Library website or can be requested by emailing irb@brcn.edu. All completed forms are submitted to irb@brcn.edu.

Please submit a Final Report form to the IRB after collection of data and any follow-up/member checking of results with participants are done.

Karen Mayville, PhD, RN
IRB Chair
July 29, 2015

Marilyn Shepherd, PhDc, RN, MBA
Blessing-Rieman College of Nursing
11th at Broadway
Quincy, IL 62301

Dear Ms. Shepherd,

The IRB reviewed your request of a waiver of HIPAA Authorization/use of PHI according to review procedures under 21 CFR 56.110 and 45 CFR 46.110. A waiver of HIPAA Authorization was granted by the IRB pursuant to 45 CFR 164.512(i)(1)(i)(A) for the study, Analysis of an Early Warning System to Determine the Association with Pressure Ulcer Risk, which is a secondary analysis of data collected for the study, A Retrospective Study of the Impact of Increased Nursing Staff Use of the Rothman Index System on Patient Care at Blessing Hospital. The IRB determined that the waiver satisfied all of the following criteria:

• The use or disclosure of the protected health information involves no more than a minimal risk to the privacy of individuals.
• The plan to protect identifiers from improper use and disclosure is adequate.
• The plan to destroy the identifiers at the earliest opportunity consistent with conduct of the research is adequate, or there is a health or research justification for retaining the identifiers, or retention of the identifiers is required by law.
• The written assurances are adequate that the protected health information will not be reused or disclosed to any other person or entity except as required by law, for authorized oversight of the research study, or for other research for which the use or disclosure of protected health information would be permitted by state and federal laws, including the HIPAA Privacy Rule.
  • The research could not practicably be conducted without the waiver.
  • The research could not practicably be conducted without access to and use of the protected health information.

The only PHI that can be accessed, used, and disclosed for this study is age because age will be used to describe the sample and is a factor influencing outcomes, mortality rates, and readmissions. The following patient data are deemed necessary to answer the study’s research questions and were collected for the original study. Therefore, these patient data can be released to the PI: age, length of stay in days, Rothman Index (RI) at discharge, patient’s discharge disposition, number of rapid response team calls, RI 48-hours prior to patient death in the hospital, readmitted to hospital within 30 days of hospital discharge, diagnosis (include all), case mix index, number of times RI viewed/used, and discharged Braden Risk Assessment Score (BRAS).

Although this study is a secondary analysis of data from a previous study, the PI is requesting additional patient data when the original data is retrieved from the medical record. These data are: the pressure ulcer is identified as present on admission (POA) or hospital-acquired (HAPU). This information is deemed necessary to answer the study’s research questions and can also be released to the PI.

The IRB only approved the collection of the above PHI and/or the health/medical information that was identified by the study’s data collection tool(s) and information submitted on the HIPAA Authorization Form. Changes or additions to the PHI and/or health/medical information collected by this study must be reviewed and approved by the IRB before they are implemented.

Karen Mayville, PhD, RN
IRB Chair
APPENDIX E.
Data use agreement

DATA USE AGREEMENT

This DATA USE AGREEMENT (this "Agreement"), dated as of this 30th day of July, 2015 by and between

Blessing Hospital,
an Illinois not-for-profit corporation ("Covered Entity"),

and

Marilyn Shepherd, PhD(c), MBA, CNE, CDE, CWOCN,
Principal Investigator
for
Research study entitled
Analysis of an Early Warning System to Determine the Association with Pressure Ulcer Risk
("Authorized User").

RECITALS:

WHEREAS, Authorized User performs certain functions (the "Activities") which are recognized under the Health Insurance Portability and Accountability Act of 1996 and the privacy regulations promulgated thereunder, including 45 CFR § 164.514, as amended from time to time (the "Privacy Rule") as activities for which Covered Entity is permitted to disclose certain Protected Health Information, excluding Direct Identifiers, as defined below, (the "Limited Data Set");

WHEREAS, to facilitate the release of the Limited Data Set pursuant to the Privacy Rule, the parties have agreed to enter into this Agreement setting forth their rights and responsibilities regarding the use and disclosure of the Limited Data Set;

WHEREAS, Authorized User agrees to limit its use of the Limited Data Set and protect the Limited Data Set according to the terms and conditions of this Agreement, the Privacy Rule and all applicable state laws.

NOW, THEREFORE, in consideration of the mutual agreements, covenants, terms and conditions herein contained, Covered Entity and Authorized User agree as follows:

ARTICLE I
DEFINITIONS

"Direct Identifiers" means, with respect to any individuals or such individual's family members, names; postal address information, other than town or city, state and zip code; telephone numbers; fax numbers; electronic mail addresses; social security numbers; medical record numbers; health plan beneficiary numbers; account numbers; certificate/license numbers; vehicle identifiers and serial numbers, including license plate numbers; device identifiers and serial numbers; web universal resource locators (URLs); internet protocol (IP) address numbers; biometric identifiers, including finger and voice prints; full-face photographic images and any comparable images.

"Individually Identifiable Health Information" shall mean information that is a subset of health information, including demographic information collected from an individual, and which (i) is created or received by a health care provider, health plan, employer, or health care clearinghouse; and (ii) relates to the past, present, or future physical or mental health or condition of an individual; the provision of health care to an individual; or the past, present or future payment for the provision of health care to an individual; and (a) identifies the individual, or (b) there is a reasonable basis to believe the information can be used to identify the individual.

"Protected Health Information" shall mean Individually Identifiable Health Information that is (i) transmitted by electronic media; (ii) maintained in any medium constituting electronic media; or (iii) transmitted or maintained in any other form or medium. "Protected Health Information" shall not include (i) education records covered by the Family Educational Right and Privacy Act, as amended, 20 U.S.C. § 1232g(a)(4)(R)(iv) and (ii) records described in 20 U.S.C. § 1232g(a)(4)(R)(iv).
ARTICLE II

DISCLOSURE OF LIMITED DATA SET TO AUTHORIZED USER

Section 2.1 Activities. Authorized User shall use the Limited Data Set only for such Activities as are set forth on Exhibit A, attached hereto and incorporated herein. Authorized User shall not materially alter the Activities for which it uses the Limited Data Set without obtaining the prior written approval of Covered Entity. Authorized User represents and warrants to Covered Entity that it will not use or further disclose the Limited Data Set in a manner that would violate the Privacy Rule, if so used or disclosed by the Covered Entity.

Section 2.2 Content of Limited Data Set. Covered Entity agrees to disclose the Limited Data Set, including the type of Protected Health Information listed on Exhibit B, to Authorized User for use by Authorized User in the performance of the Activities.

Section 2.3 Minimum Necessary Information. Authorized User represents and warrants to Covered Entity that the Limited Data Set provided for in this Agreement represents the minimum necessary Protected Health Information required for its performance of the Activities.

ARTICLE III

USE AND TRANSFER OF LIMITED DATA SET

Section 3.1 Use of Limited Data Set. Authorized User may use and disclose the Limited Data Set only as permitted under the terms of this Agreement or as required by law, but shall not otherwise use or disclose the Limited Data Set and shall ensure that its directors, officers, employees, contractors and agents do not use or disclose the Limited Data Set in any manner that would constitute a violation of the Privacy Rule if used by Covered Entity.

Authorized User agrees not to use the Limited Data Set in such a way as to identify any individual and further agrees not to contact any individual. Authorized User shall limit the use or receipt of the Limited Data Set to the individuals or classes of individuals set forth on Exhibit C.

Section 3.2 Third-Party Contractors. Authorized User shall obtain and maintain a Use Agreement with each agent or subcontractor of Authorized User that acquires access rights to the Limited Data Set. Such agreement shall obligate the agent or subcontractor to comply with the terms and conditions of use of the Limited Data Set, as set forth in this Agreement and in the Privacy Rule.

ARTICLE IV

CONFIDENTIALITY AND OWNERSHIP OF LIMITED DATA SET

Section 4.1 Confidentiality of Limited Data Set. Authorized User shall use all appropriate safeguards to prevent use or disclosure of the Limited Data Set other than as permitted under this Agreement. Authorized User shall not re-disclose all or part of the Limited Data Set, except as provided for in this Agreement, without the prior written authorization of Covered Entity; shall not use the Limited Data Set, directly or indirectly, other than for carrying out Authorized User’s purposes, as documented in this Agreement; shall keep the Limited Data Set confidential and ensure that its affiliates, officers, agents, advisors, employees and/or representatives who have access to the Limited Data Set for purposes of carrying out the Authorized User’s purposes as set forth in this Agreement comply with the nondisclosure obligations contained in this Article IV and as otherwise provided for in this Agreement. Authorized User agrees to be responsible for any breach of this Article IV by its affiliates, officers, agents, advisors, employees and/or representatives. If Authorized User is requested or required as a result of a judicial or regulatory proceeding to disclose all or any part of the Limited Data Set, Authorized User agrees to provide Covered Entity with immediate notice thereof so that Covered Entity may seek an appropriate protective order, if it deems such an order necessary and appropriate to protect the Protected Health Information provided to Authorized User under this Agreement; provided that, if such protective order is not obtained, Authorized User may disclose all or any part of the Limited Data Set if required to do so by any court or regulatory authority having jurisdiction over Authorized User.

It is understood and agreed that money damages would not be a sufficient remedy for any breach of this Article IV and that Covered Entity shall be entitled to seek specific performance and injunctive or other equitable relief, in addition to all other remedies available at law or equity, as a remedy for any such breach, without the necessity of security or the posting of any bond.
Section 4.2 Return of Protected Health Information upon Termination. In the event that either party terminates this Agreement, Authorized User agrees to return to Covered Entity any and all documents, records, claims information, notes, communications, writings, charts, or other recorded matter of any kind documenting all or any part of the Limited Data Set provided under this Agreement.

Section 4.3 Reporting of Disclosures of Protected Health Information. Authorized User shall report to Covered Entity any use or disclosure of the Limited Data Set in violation of this Agreement or the Privacy Rule by Authorized User, or its officers, directors, employees, contractors, agents or any other third party to whom Authorized User supplied the Limited Data Set within seven (7) days of obtaining knowledge of such disclosure.

Section 4.4 Ownership of Information Contained in Limited Data Set. Authorized User acknowledges that, as between Authorized User and Covered Entity, all Protected Health Information shall be and remain the sole property of Covered Entity, including any and all forms thereof developed by Authorized User in the course of its fulfillment of its obligations pursuant to the Agreement.

ARTICLE V

INDEMNIFICATION

Authorized User shall indemnify, hold harmless and defend (if requested by Covered Entity) Covered Entity and its officers, directors and members (all of the foregoing collectively referred to in this Article V as the "Indemnitees") from and against any and all liabilities, costs, expenses and damages, including attorneys' fees, actually and necessary incurred by or imposed on any of the Indemnitees in connection with or resulting from any claim, action, suit or proceeding, whether civil, criminal, administrative or investigative, or any appeal thereon, with which an Indemnitee may be or become involved or with which an Indemnitee may be threatened, as a party or otherwise, as a direct or indirect result of any actions or omissions of Authorized User, its agents or subcontractors, including failure to perform its obligations under this Agreement, or as a result of Authorized User's negligence or willful misconduct in its performance of its duties under this Agreement.

ARTICLE VI

INSURANCE

Authorized User shall obtain and maintain and during the term of the Agreement liability insurance covering claims based on a violation of the Privacy Rule or any applicable state law or regulation concerning the privacy of patient information and claims based on its obligations pursuant to this Agreement in an amount not less than $1,000,000 per claim and $3,000,000 annual aggregate. To the extent that such insurance is purchased on a "claims made" basis, Authorized User agrees to purchase appropriate "tail" coverage upon termination of this Agreement. All insurance coverage shall name Covered Entity as an additional named insured. A copy of the policy or certificate evidencing such coverage shall be provided to Covered Entity upon execution of this Agreement. Authorized User shall immediately notify Covered Entity of any amendment, modification, renewal, or cancellation of the insurance coverage provided for in this Article VI.

ARTICLE VII

TERM AND TERMINATION

Section 7.1 Term. The Term of this Agreement shall be two (2) year(s), such Term to run concurrently with the conclusion of a research study entitled Analysis of an Early Warning System to Determine the Association with Pressure Ulcer Risk. Agreement executed between the parties.

Section 7.2 Termination For Cause. Covered Entity shall notify Authorized User in writing in the event that Covered Entity becomes aware that Authorized User is or has breached any provision of this Agreement regarding the protection of or restrictions on the use of the Limited Data Set. Authorized User shall have seven (7) days from the date of such notice to cure such breach. In the event that such breach is not cured to the satisfaction of Covered Entity within such period, Covered Entity shall have the right to terminate this Agreement immediately and without further notice to Authorized User. Authorized User acknowledges and agrees that in the event Authorized User's efforts to cure the breach
are unsuccessful, Covered Entity must, under the Privacy Rule, report the breach to the Department of Health and Human Services.

Section 7.3 **Termination Without Cause.** Either party may terminate this Agreement without cause upon ninety (90) days written notice to the other party.

**ARTICLE VIII**

**GENERAL PROVISIONS**

Section 8.1 **Amendment.** Authorized User and Covered Entity agree to amend this Agreement to the extent necessary to allow either party to comply with the Privacy Rule, the Standards for Electronic Transactions (45 C.F.R. Parts 160 and 162) and the Security Standards (45 C.F.R. Part 142) promulgated or to be promulgated by the Department of Health and Human Services or other statutes or regulations. Authorized User agrees that it will fully comply with all such statutes and regulations and that it will agree to amend this Agreement to incorporate any material changes required by such statutes and regulations.

Section 8.2 **Notices.** All communications hereunder shall be in writing and shall be delivered personally or sent by registered or certified mail, return receipt requested, to the following addresses:

- **If to Covered Entity:** Betty Kasparie, Privacy Officer  
  Blessing Hospital  
  1005 Broadway, PO Box 7005  
  Quincy, IL 62355-7005

- **If to Authorized User:** Marilyn Shepherd, PhD(c), MBA, CNE, CDE, CWOCN  
  Blessing-Rieman College of Nursing  
  Broadway at 11th Street  
  Quincy, IL 62355

All communications shall be deemed effective upon receipt.

Section 8.3 **Entire Agreement; Waiver.** All prior agreements, contracts, promises, representations and statements, if any, between the parties hereto or their representatives, with respect to the matters covered hereby, are merged into this Agreement, and this Agreement represents the entire agreement between the parties hereto with respect to the matters covered hereby. No waiver or modification of the terms hereof shall be valid unless in writing signed by the party to be charged and only to the extent therein set forth.

Section 8.4 **Assignment.** This Agreement shall be binding upon and inure to the benefit of the parties hereto and their respective successors and assigns; provided, however, that this Agreement may not be assigned by either party without the prior written consent of the other.

Section 8.5 **Severability.** If any provision or part thereof of this Agreement is found to be prohibited, unenforceable or invalid under the laws of any jurisdiction, the provision or part thereof shall be ineffective to the extent of such prohibition, unenforceability or invalidity under the applicable law without affecting the enforceability or validity of such provision in any other jurisdiction, and without invalidating the remainder of such provision or other provisions of this Agreement.

Section 8.6 **Survival.** Articles IV, V and VI shall survive termination of this Agreement for any reason.

Section 8.7 **Captions.** Captions are provided for convenience only and are not part of this Agreement and shall not be used in the interpretation of this Agreement.

Section 8.8 **Counterparts.** This Agreement may be executed in multiple counterparts, each of which shall be deemed an original but all of which shall constitute one and the same instrument.
IN WITNESS WHEREOF, the parties have caused this Agreement to be executed as of the day and year first written above.

COVERED ENTITY
By: Patricia J. Kasparie
Its: Privacy Office

AUTHORIZED USER
By: Mark S. Sheppard, RN, PhD
As: Principal Investigator
APPENDIX F.
Permission letter to use Braden Risk Assessment Scale

Date: March 3, 2016

To: Marilyn Shepherd, PhD – University of Missouri-Columbia

From: Barbara Braden, PhD, RN, FAAN, Nancy Bergstrom, PhD, RN, FAAN

RE: Permission to use the Braden Scale*

As holders of the official copyright for the Braden Scale for Predicting Pressure Sore Risk and the interventions, we hereby grant permission for the use of scale in your dissertation manuscript.

*It is understood that the wording or scoring of the scale may not be changed in any way. The title and copyright acknowledgement must be used also.

[Signature]

[Signature]
Michael J. Rothman, PhD <mrothman@perahealth.com>
Tue 3/15/2016 5:14 PM

To:
Shepherd, Marilyn;

Cc:
Stephanie Alexander <salexander@perahealth.com>;

Marilyn,
You have my permission to use the RI in your research.
You may also use the table listing the 26 factors... all with proper attribution of course.
Please let me know if I can assist in answering any questions.

By the way, I've shown our work to Nancy Bergstrom, Barbara's collaborator... Nancy is enthusiastic about our work with the RI.

With my regards,
Michael

Michael Rothman, PhD
Chief Science Officer
PeraHealth

845-223-3900

Sent from my iPhone
APPENDIX H.

Formulas used in manuscript

Pressure ulcer period prevalence:

For this study, the formula by which period prevalence was calculated as follows:

The number of individuals who had a pressure ulcer over a specific time period divided by the total number of individuals in the study population over the same specific time period multiplied 100 (National Pressure Ulcer Panel Advisory Panel, 2012).

RI review/ LOS

For this study, the formula by which RI view was normalized is as follows:

The number of times the nurse viewed the Rothman Index score divided by the length of stay multiplied by 100.
APPENDIX I.

Permission letter to use information

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