December 2013

Representing and Retrieving Patients' Falls Risk Factors and Risk for Falls Among Adults in Acute Care Through the Electronic Health Record

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REPRESENTING AND RETRIEVING PATIENTS' FALLS RISK FACTORS AND RISK FOR FALLS AMONG ADULTS IN ACUTE CARE THROUGH THE ELECTRONIC HEALTH RECORD

by

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A Dissertation Submitted in

Partial Fulfillment of the

Requirements for the Degree of

Doctor of Philosophy

in Nursing

at

The University of Wisconsin-Milwaukee

December 2013

ABSTRACT

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The University of Wisconsin-Milwaukee, 2013

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Defining fall risk factors and predicting fall risk status among patients in acute care has been a topic of research for decades. With increasing pressure on hospitals to provide quality care and prevent hospital-acquired conditions, the search for effective fall prevention interventions continues. Hundreds of risk factors for falls in acute care have been described in the literature. However, due to variations in the terms utilized to represent each fall risk factor, an effort to compare findings across settings and replicate research is hampered. As the expectations for the effective use of electronic health records increase, an opportunity exists to create infrastructure within clinical information systems, constructed with evidence-based knowledge and standardized terms, that will support interoperability between systems and enable comparative research. The purpose of this study is to identify to what extent selected fall risk factors and the problem, 'risk for falls' are represented and retrievable, in patients' electronic health record, in one acute care setting. Specifically, this study sought to answer

three questions: 1) How can the selected fall risk factors and the problem, 'risk for falls' be represented through selected standardized terminologies? 2) How are the selected fall risk factors and problem, 'risk for falls' represented in a clinical information system? and 3) Which of the selected fall risk factors and problem, 'risk for falls' can be retrieved from the electronic health record? The study was guided by the Knowledge Based Nursing Initiative (KBNI) framework. The study was conducted at a local health system within the hospital division, utilizing electronic, patient clinical data. Five selected fall risk factors and the problem, 'risk for falls,' were mapped to five standardized terminologies utilizing lexical matching. The terms mapped from the five terminologies were compared to the terms, located in discrete fields within the study site's clinical information system. In addition to SNOMED CT and ICD-9 CM terms, a mixture of vendor and site-specific terms that represented the problem, 'risk for falls,' and the five selected fall risk factors were located in the study site's clinical information system. The mapped ICD-9 CM terms and fourteen of the twenty-two SNOMED CT terms were located in the '*Problem List'* and '*Medical History'* sections of the clinical information system, while the vendor and site-specific terms were located in '*Orders*,' '*Nursing Flow Sheet*,' and '*Rehabilitation Flow Sheet'* sections. Although both the ICD-9 CM and SNOMED CT terminologies were visible to the clinicians, one of the two mapped SNOMED CT terms representing the problem, 'risk for falls,' and fourteen of the twenty-two mapped fall risk factors were not visible because they did not correspond to ICD-9 CM terms. Site-specific terms representing 'cognitive impairment' and 'impaired gait' were located in both the

'*Nursing Flow Sheet'* and '*Rehabilitation Flow Sheet'* section. While the terms were lexically similar, the terms were not exact matches and the machine-readable codes differed.Data recorded in 995 episodes of care were retrieved from the electronic data warehouse for analysis. While the SNOMED CT terms were not available for retrieval from the electronic data warehouse, the ICD-9 CM, vendor, and site-specific terms were available. As there were not SNOMED CT terms available for retrieval from the electronic data warehouse, the representation of the problem, 'risk for falls,' was not retrievable as a standardized term; however, it was retrieved as a Morse Fall Scale score of 40 or greater among 64.7% of the sample. The percentage of the five fall risk factors represented with the ICD-9 CM terms was lower than the percentage of fall risk factors represented with vendor and site-specific terms. While it is promising that two standardized terminologies have been embedded in the study site's system, limiting the SNOMED CT terms to those that have corresponding ICD-9 terms limits the representation of both the problem, 'risk for falls,' and the five selected fall risk factors. It is recommended that hospital administrators embed standardized terminologies in their entirety to allow for adequate representation of terms. Accepting terminologies in their entirety would allow for interoperability between health systems and enable comparative research. Additionally, if vendor and site-specific terms are embedded, clinical information analysts in partnership with clinicians should assure that terms representing the same clinical data (e.g., disorientation), match across different sections of the clinical information system

or a cross-mapping of those terms exist in order to support interoperability within the system.

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Chapter 1: Introduction

In 2010, just over 26,000 US citizens died as a result of a fall (Hoyert & Xu, 2012). The US Census Bureau predicts that there will be 72 million people age 65 years old or older by the year 2030 (U.S. Department of Commerce, 2006). One-third of older adults fall every year (Centers for Disease Control and Prevention, 2012b). If the current trends continue, there may be over 23 million falls in the year 2030. Falls that occur in acute care have recently been given more attention, as acute care facilities are no longer reimbursed for treating injuries incurred as the result of a fall (Centers for Medicare and Medicaid, 2008). Acute care facilities are increasingly expected to prevent falls and fall-related injuries, but the consistency of 'how' to assess for risk for falls and 'what' risk factors to assess differ across studies. The confusion may be partially due to the various terms utilized to represent the problem, 'risk for falls' and fall risk factors in research, which limits comparisons across studies. Thus, identification of who is at risk for falls in acute care and which fall prevention interventions are effective continues to be a challenge.

The development of the electronic health record (EHR) and the employment of standardized terminologies to represent patient clinical data are now an expectation (Lundberg et al., 2008). However, the representation of nursing collected patient data with standardized terminologies and the ability to retrieve that data from clinical data repositories is limited (Lang, 2008). This section begins with a review of the frequency and the devastating consequences of falls. This section also includes an introduction to the various terms utilized to represent the problem, 'risk for falls,' and selected fall risk factors in acute care

and an introduction to how researchers have retrieved data on patients' fall risk factors and fall risk status. This section concludes with the assumptions, limitations, and purpose of the current study.

Statement of the Problem

Falls and Consequences. Although the occurrence of falls among the US population is not known, it has been estimated to be in the millions per year (Adams, Martinez, Vickerie, & Kirzinger, 2011; Shumway-Cook et al., 2009; Stevens, Mack, Paulozzi, & Ballesteros, 2008). An analysis of the 2006 Behavioral Risk Factor Surveillance Survey (BRFSS) found that among people 65 years old and older, 15.9% reported falling within the preceding three months which, when extrapolated to the US population, would have equaled 5.8 million falls for this age group alone (Stevens et al., 2008). Across the world, there are an estimated 37.5 million falls that require medical attention (World Health Organization, 2012).

In acute care, falls are often, but not consistently, expressed as a rate per 1,000 patient days. The rates at which patients fall in acute care often differ by unit, population, and setting. Fall rates in medical/surgical units range between 1.97 and 5.85 per 1,000 patient days (Bradley, Karani, McGinn, & Wisnivesky, 2010; Dykes et al., 2010). Fall rates on geriatric units have been reported to be as high as 11.7 per 1,000 patient days (Schwendimann, Buhler, De Geest, & Milisen, 2006). One study found 16.3 falls per 1,000 patient days among post-op femoral neck fracture patients (Stenvall et al., 2006). Other studies did not report fall rates per 1,000 patient days, but instead reported a percentage of patients

who fell or the number of falls over a given time period. For example, a recent fall prevention randomized controlled trial reported the percentage of falls among the intervention (0.4%) and controlled (1.5%) groups on medical units (Ang, Mordiffi, & Wong, 2011). If the raw data are not included in study reports, variation in how outcomes are measured further limits comparisons across studies.

Several studies have shown that falls result in injuries, increased health care costs, and death. The results of the 2010 National Health Interview Survey (NHIS) concluded that among all ages, excluding people who were institutionalized, there were 13 million falls that caused enough injury to prompt medical consultation (Adams et al., 2011). In 2005, among older adults, there were 56,423 fall-related traumatic brain injuries that required hospitalization (Thomas, Stevens, Sarmiento, & Wald, 2008). Another study found that, between the years 2001 and 2008, there was a 50% increase in hospital admissions due to a fall-related injuries with 63% of those admissions due to fractures (Hartholt, Stevens, Polinder, van der Cammen, & Patka, 2011). In 2000, there were 2.6 million fall-related injuries accounting for 12 billion dollars spent to cover hospitalization costs, 4 billion dollars spent on emergency department visits and another 3 billion dollars on outpatient/physician office visits (Stevens, Corso, Finkelstein, & Miller, 2006). In 2020, it is estimated that the financial burden of health care costs associated with older adult fall-related injuries will reach $85.37 billion dollars (based on 1994 dollars) (Englander, Hodson, & Terregrossa, 1996). The death rate from falls in the US, rose from 4.8 per 100,000 people in

1999, to 7.2 in per 100,000 people in 2007 (Centers for Disease Control and Prevention, 2011).

Patients who fall in acute care and sustain serious injuries average $13,806 more in hospital cost, 6.3 additional days of inpatient care and immeasurable pain and suffering (Wong et al., 2011). In Canada, serious injury due to a fall in the hospital results in an average additional $36,781 in cost and 37 additional days in the hospital (Zecevic et al., 2012). It has been projected that in the US, more than 11,000 patients per year will die as a result of a fall during a hospitalization (Currie, 2008). Even one death is too many for the family members and the caregivers. Falls are frequent and result in costly, life changing and in some cases, fatal consequences. Falls remain a significant problem worthy of continued study. This study aimed to contribute to the understanding of falls by describing how falls risk factors and the problem, risk for falls, can be represented in, and retrieved from patients' clinical records to support comparative falls research across settings.

Representation and Retrieval of 'Risk for Falls'. The American Nurses Association's (ANA) definition of a fall is, "…an unplanned descent to the floor (or extension of the floor, e.g., trash can or other equipment) with or without injury to the patient, and occurs on an eligible reporting nursing unit" (American Nurses Association [ANA], 2010). While this definition of a fall is explicit, how 'risk for falls' is represented in patients' clinical records varies between facilities and across falls risk research. 'Risk for falls' can be represented by the North American Nursing Diagnosis Association-International (NANDA-I) diagnosis

(Herdman, 2012) or a concept within the Systematized Nomenclature for Medicine Clinical Terms (SNOMED CT) terminology, but the representation of nursing data with standardized terminologies is not standard across health systems (Park & Cho, 2009). Among the reports reviewed for this research, none described the use of either the NANDA-I diagnosis or SNOMED CT concept to represent falls risk in the clinical record.

In addition to the diagnosis, “risk for falls,” there are a number of fall risk assessment tools that have been designed to predict a patient’s ‘risk for falls’ and represent a patient’s fall risk status as a numerical score. Fall risk assessment tools consist of a selected set of fall risk factors that have been found to predict falls, but the risk factors in each assessment tool and the terms utilized to represent those risk factors differ. The Morse Fall Scale (Morse, 2009), the Hendrich II (Hendrich, Bender, & Nyhuis, 2003), the St. Thomas Risk Assessment Tool in Falling Elderly Patients (STRATIFY) (E. A. Kim, Mordiffi, Bee, Devi, & Evans, 2007), the Fall Risk Assessment Score (FRAS) (El Miedany, El Gaafary, Toth, Palmer, & Ahmed, 2011), the Western Hospital eFall Risk Assessment (WHeFRA) (Walsh, Hill, Bennell, Vu, & Haines, 2011), the Spartanburg Fall Risk Assessment Tool (Robey-Williams et al., 2007) and the Johns Hopkins Hospital Fall Assessment Tool (Poe, Cvach, Dawson, Straus, & Hill, 2007) are a few examples of fall risk assessment tools that can be used to represent ‘risk for falls’ in acute care. While retrieval of both patients’ fall risk status and fall risk factors have been completed through electronic extraction of patient data from clinical repositories in a few studies (Giles et al., 2006; Titler,

Shever, Kanak, Picone, & Qin, 2011), most falls risk research data are retrieved through a manual review and abstraction from the clinical record (Capone, Albert, Bena, & Morrison, 2010; Tanaka, Suemaru, Ikegawa, Tabuchi, & Araki, 2008).

Representation and Retrieval of Falls Risk Factors. Like the problem, 'risks for falls', individual fall risk factors are represented in the literature with a variety of terms. Currie (2008) cites 'unsteady gait' as a fall risk factor, while Amador & Loera (2007) cite, 'balance or gait problems.' Impaired gait can be represented with the ICD-9 CM code 'abnormality of gait' or the SNOMED CT concept 'abnormal gait'. Among reports that describe how fall risk factors were represented in the clinical record, few were found that included fall risk factors in terms from a standardized terminology (Brand & Sundararajan, 2010). Unfortunately, across many falls risk studies, how fall risk factors, such as impaired gait, are represented in the clinical record has not been described. Many only described that fall risk factors were retrieved from the record, without detail of what terms or terminologies were used to represent the risk factor (Capone et al., 2010; X. L. Chen, Liu, Chan, Shen, & Van Nguyen, 2010; M. Ferrari, Harrison, & Lewis, 2012; Schmid et al., 2010). As with the problem, 'risk for falls', fall risk factor data have been retrieved from a variety of sources, with a variety of methods across studies. Few were found that retrieved fall risk factor data through extraction of electronic data from clinical repositories (Brand & Sundararajan, 2010; Titler et al., 2011). Most simply describe that data were retrieved from the record (Capone et al., 2010; X. L. Chen et al., 2010; X. Chen, Van Nguyen, Shen, & Chan, 2011; Lakatos et al., 2009). Others reported

retrieval of fall risk factor data through a manual review of electronic health records (Chang et al., 2011; M. Ferrari et al., 2012) while some retrieved data from a combination of manual medical record review and post-fall incident report review (Lakatos et al., 2009; Rhalimi, Helou, & Jaecker, 2009; Tanaka et al., 2008).

Standardized Terminology in Electronic Health Records (EHR). The employment of standardized terminologies in the electronic health record to represent nursing collected patient data has been deemed 'essential' (National Library of Medicine (U.S.). Board of Regents, 2006) but remains a challenge. The use of standardized terminologies to represent nursing collected patient data has been problematic. Nurses feel unprepared to use standardized terminologies (Thede, 2012) and may not have had education related to terminologies (Park & Cho, 2009). Additionally, clinical information systems have not been constructed to represent nursing data in a retrievable fashion, which limits research methods to manual extraction of data (Lang, 2008). Finally, because there are a variety of standardized terminologies available and no standards related to terminology use (Bowles et al., 2013), each health system has the choice of which to include in the clinical information system or may choose to create their own terminology (Park & Cho, 2009; Watkins et al., 2009).

Standardized Terminologies

There are a variety of standardized terminologies that were developed to represent medical and/or nursing domain concepts. According to the American Nurses Association (ANA), there are thirteen standardized terminologies suited

to represent the concepts of nursing practice (Park & Cho, 2009). Among those recognized by the ANA, the North American Nursing Diagnosis Association International (NANDA-I) and the Systematized Nomenclature for Medicine Clinical Terms (SNOMED CT) have been selected for use in this research. In addition, as several fall risk factors can be represented as diseases, the International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9 CM) was selected for inclusion in this research. The American Hospital Formulary Service (AHFS) Pharmacological Therapeutic Classification system was included to ensure representation of the pharmacological fall risk factors. Finally, the Aurora "Risk for Falls" constraint group dataset found in the United States Health Information Knowledgebase (USHIK) database was selected to explore an example of the representation of falls risk with a health-system specific terminology.

Summary

While this research focuses on the variation in representing and retrieving fall risk factors, the same analysis is needed to address the variations that exist in studies on fall prevention and outcomes. Coussement et al. (2008) completed a systematic literature review and meta-analysis of fall prevention studies published between January 1966 and June 2006 with only eight studies ultimately being included in the final meta-analysis. The researchers suggested that the failure of the analysis to find a significant pooled effect (RR_{fall}) was partially due to the limited number of comparable studies and that the fall risk assessments and interventions differed greatly between studies (Coussement et

al.). A recent Cochrane Review (Cameron, 2010) also reported that the variations in fall interventions was a limitation of the review findings. In addition to variation in interventions, both reviews included studies with a variety of outcomes. Cameron (2010) included studies with the number of falls, the number of fallers and fall rates, while Coussement et al. (2008) included studies with the number of falls, number of fallers, number of recurrent fallers, and time until first fall. Identifying risk for falls in acute care has been an interest to researchers for decades, as evidence by the number of fall risk tools produced over the years (Haines, Hill, Walsh, & Osborne, 2007; Myers, 2003); however, because of the variation in representing and measuring fall related outcomes, fall risk assessments, and fall prevention interventions, comparison between studies has been limited. Based on the of number hospitalizations in the US and a 3% fall rate, Currie (2008) predicted that falls among hospitalized patients could someday reach one million per year. By standardizing the terms utilized to represent fall risk factors and the problem, 'risk for falls,' and optimizing the use of data extraction, researchers would not only be able to compare findings across studies, but also collaborate in powerful research.

Purpose and Research Questions

The diversity with which the problem, 'risk for falls,' and fall risk factors are represented in and retrieved from clinical records in acute care presents a challenge to efforts to address the problem. Without standardized terms, definitions and measurement methods across the studies of falls and risk for falls, comparison across studies is limited. With the advent of the electronic

health record and clinical data repositories, researchers have the potential to collect fall risk factors on thousands of patients as discrete bytes of data, without using labor intensive, page-by-page manual chart review. The purpose of this study is to identify to what extent selected fall risk factors and the problem, 'risk for falls' are represented and retrievable, in patients' electronic health record, in one acute care setting. Specifically, this study sought to answer three questions: 1) How can the selected fall risk factors and problem, 'risk for falls' be represented through selected standardized terminologies? 2) How are the selected fall risk factors and problem, 'risk for falls' represented in a clinical information system? and 3) Which of the selected fall risk factors and problem, 'risk for falls' can be retrieved from the electronic health record?

Conceptual Framework

The framework used to guide this research was the Knowledge Based Nursing Initiative (KBNI). The Aurora, Cerner, University of Wisconsin-Milwaukee (ACW) Knowledge Based Nursing Initiative (KBNI) framework supports the translation of evidence-based nursing practice into an electronic format, built as actionable items into a clinical decision support system that can subsequently be extracted electronically, not only to inform practice and quality measures, but to provide further data for research (Lang, 2008). The framework is composed of six components: (1) knowledge development; (2) knowledge representation; (3) prototype development; (4) live environment implementation including clinical decision support; (5) data extraction and analysis using data from the clinical repository; and (6) dissemination of the results (Lang, 2008; University of

Wisconsin, 2012). The focus of this study was on the following components: (2) knowledge representation; and (5) a limited analysis of issues involved in the data extraction and analysis related to the selected fall risk factors.

Definitions

Risk Factor- "Environmental factors, physiological, psychological, genetic, or chemical elements that increase the vulnerability of an individual, family, group, or community to an unhealthy event." (Herdman, 2012, p.342).

Intrinsic Fall Risk Factors-"Patient-related physiological and psychological factors" (Choi, Lawler, Boenecke, Ponatoski, & Zimring, 2011, p. 2519).

Risk for Falls-" …increased susceptibility to falling that may cause physical harm" (Herdman, 2012, p.285).

Fall- "An unplanned descent to the floor (or extension of the floor, e.g., trash can or other equipment) with or without injury to the patient…"(American Nurses Association [ANA], 2010, p. 13)

Standardized Terminology-"discipline focused language" (Jones, Lunney, Keenan, & Moorhead, 2010, p. 254)

Assumptions

- Significant fall risk factors among patients in acute care can be found in the evidence.

Limitations

- No control over events that may influence the recording of variables measured for the study
- Generalizability beyond the current sample is limited

- Limited use of standardized/interoperable data in the research site

Chapter 2: Review of the Literature

While there is agreement that patients in acute care should be assessed for 'risk for falls' (Currie, 2008; Healey & Scobie, 2007; Hook, Devine, & Lang, 2008; Institute for Clinical Systems Improvement, 2010; Oliver, Healey, & Haines, 2010), there is less agreement on 'how' that risk is represented in the patient's clinical record. The problem, 'risk for falls' and individual fall risk factors are represented with various terms in the patient's clinical record and often are not represented in terms recognized by a standardized terminology. This limits interoperability between facilities and comparison across research. As the expectations for the effective use of electronic health records increase, an opportunity exists to create an infrastructure within clinical information systems, constructed with evidence-based knowledge and standardized terms, that will support interoperability between systems and enable comparative research. The purpose of this study is to identify to what extent selected fall risk factors and the problem, 'risk for falls' are represented and retrievable, in patients' electronic health record, in one acute care setting.

The following section review the recent literature describing the representation of selected fall risk factors and the problem, 'risk for falls' and the challenges related to the use of standardized terminologies to represent patient data in the electronic health record. The section continues with a brief review of the recent evidence that continues to support the five selected fall risk factors as significant fall risk factors in acute care. The section concludes with a review of

five selected standardized terminologies and an overview of the conceptual framework used to guide the study.

Representation and Retrieval of Patients' Falls Risk

Literature search. A review of recent falls risk research was completed in order to describe how the problem, 'risk for falls,' and selected fall risk factors have been represented in patient clinical records and how each was retrieved for the research. Results of a 2011 literature search, completed by the Knowledge Based Nursing Initiative (KBNI) reference librarian in August of 2011, were combined with the results of a more recent literature search completed by the researcher. The August 2011 search dates ranged from January 1, 2006 to July 31, 2011 and included studies located through a search of several databases and internet sites. Key words utilized in the 2011 search included, "falls," "accidental falls," "risk assessment," "risk factors," "risk management," and "falls assessment." Additional terms were combined with the key words or phrases, such as "inpatient accidents," "fall intervention," "hospital admission," and "hospitalization." Not all key words and phrases were listed here as the 2011 search was intended to not only identify literature on fall risks but also fall prevention. When applicable in the database, the search was limited to human studies published in English. Studies were also limited to meta-analyses, systematic reviews, clinical trials, professional guidelines, standards of care, and articles from peer reviewed journals.

The more recent literature search was conducted by the researcher to identify additional literature published between August 1, 2011 and December

31, 2012. PubMed, CINAHL, and the Cochrane Database of Systematic Reviews were searched using the following key words or phrases: (fall), OR (accidental fall), OR ("risk factor," OR "risk assessment,"). These key words were used in combination with "hospital" OR "acute care." The PubMed search was limited, using the PubMed filters, to studies available in English, completed on humans, among adults 19 years old and older and classified as any of the following report types: (1) clinical trials; (2) randomized controlled trials; (3) evaluation studies; (4) systematic reviews; and (5) meta-analyses. The CINAHL search was limited to 'peer reviewed journals', 'inpatients' and the age group of 'all adults.' The Cochrane Database of Systematic Reviews was limited to reviews for the years 2011 and 2012.

Inclusion and exclusion criteria. Only reports that examined intrinsic fall risk factors among patients in acute care were included in the analysis. Studies conducted solely in inpatient psychiatric, pediatric, and rehabilitation settings were not included. The Knowledge-Based Nursing Initiative (KBNI) levels of evidence table was used to evaluate each report (Devine, 2007). The levels of evidence table classifies research from Level I, evidence from systematic reviews, meta-analysis or clinical practice guidelines based on randomized clinical trials, to Level VIII-clinical articles (Devine, 2007). For the purposes of this research, only studies that met the criteria of Levels I through VII were included.

Results. Five-hundred sixty-five citations were located. First, titles and abstracts were reviewed for inclusion and exclusion criteria. If no abstract was available and the title was insufficient to determine inclusion or exclusion, the

report was retrieved and reviewed. Four hundred eighty-one publications were excluded for failing to meet inclusion and/or exclusion criteria. In total, 84 articles were retrieved and reviewed in full. After an initial review, 19 additional reports were excluded for failing to meet inclusion and/or exclusion criteria, leaving 65 reports for complete analysis (See Appendix A for a summary of the reports excluded).

Representation and Retrieval of the Problem 'Risk for Falls.'

'Risk for falls,' defined as "…increased susceptibility to falling that may cause physical harm" (Herdman, 2012, p. 286), is a nursing diagnosis included in NANDA-I Taxonomy II. 'Risk for falls' can also be represented as the SNOMED CT concept, "At Risk for Falls (129839007)" (US National Library of Medicine, 2013b). However, among the reports reviewed for this research, none described the representation of fall risk status with the NANDA-I diagnosis or SNOMED CT concept. Only two reports described how patients' fall risk status was represented in the clinical record. One report described that the patients' fall risk status was represented through an electronic care planning data element labeled, 'potential for falls' (Giles et al., 2006) while Tanaka et al., (2008) described that patients' fall risk status was represented as either high, intermediate or low in the clinical record. Only Giles et al. (2006) described that data on patients fall risk status was retrieved electronically, from electronic clinical data repositories (Giles et al., 2006), while the other report described the retrieval of patients' fall risk status through a manual chart review (Tanaka et al., 2008). A third report, utilized an existing research database and extracted data

from patients who"…either had received the Nursing Interventions Classification (NIC) interventions of Fall Prevention…or were rated at risk for falling as defined by a fall risk assessment scale used by the organization." (Titler et al., 2011, pp. 126-127).

Although none of the reports described the use of the NANDA-I diagnosis, "Risk for Falls", two reports described the use of facility-specific, falls risk assessment tools to represent fall risk status. The fall risk assessment tool described by Titler et al. (2011), calculated a patient's fall risk score based upon the patient's age and an unpublished, six-item, fall risk assessment tool. A score of seven or greater represented a patient's increased risk for falls (Titler et al., 2011). The fall risk assessment tool described by Tanaka et al. (2008), included ten categories of weighted, fall risk factors, with a score of 16 or greater representing a high fall risk. While facilities may choose to design site-specific tools, there are a plethora of published fall risk assessment tools (Currie, 2008; Hook et al., 2008; Oliver, Daly, Martin, & McMurdo, 2004). The seven fall risk assessment tools that were described in the reviewed literature are discussed here. Table 1 describes the number of items in each tool, the population for whom the tool was designed and the score that represents risk for falls.

Table 1

Fall Risk Assessment Tools to Represent Risk for Falls

Tool	Score Representing "At Risk for Falls"	Description
The Morse Fall Scale (Morse, 2009)	45 or greater	Six-item tool designed for inpatients in acute care. Has been used and tested in variety acute care populations (Chapman, Bachand, & Hyrkas, 2011; Lovallo, Rolandi, Rossetti, & Lusignani, 2010; Schwendimann, De Geest, & Milisen, 2006; Schwendimann, Milisen, Buhler, & De Geest, 2006).
St Thomas Risk Assessment Tool in Falling Elderly Patients (STRATIFY) (Oliver, Britton, Seed, Martin, & Hopper, 1997)	2 or greater OR 3 or greater	Five-item tool developed and tested among elderly inpatients in the United Kingdom. Has been tested in a variety of adult inpatient populations (Barker, Kamar, Graco, Lawlor, & Hill, 2011; E. A. Kim et al., 2007; Walsh et al., 2011; Webster et al., 2008).

Table 1

Fall Risk Assessment Tools to Represent Risk for Falls

Tool	Score Representing "At Risk for Falls"	Description
Hendrich II (Hendrich et al., 2003)	5 or greater	Eight-item tool developed and validated in a large, inpatient population. Additional studies have been conducted to evaluate the predictive value of the tool, including one conducted in Singapore (E. A. Kim et al., 2007) and one in Italy (Ivziku, Matarese, & Pedone, 2011).
Fall Risk Assessment Score (FRAS) (El Miedany et al., 2011)	3.5 or greater	Seven-item self-reported fall assessment tool, designed for use with older adults in both the inpatient and outpatient settings.
The Western Hospital e Fall Risk Assessment (WHeFRA) tool (Walsh et al., 2011)	10 or greater	Five-item fall screening tool, which identified patients at risk for fall combined with a 13-item fall risk factor assessment to assist in the individualization of interventions.

Table 1

Fall Risk Assessment Tools to Represent Risk for Falls

Tool	Score Representing "At Risk for Falls"	Description
The Spartanburg Fall Risk Assessment Tool (Robey-Williams et al., 2007)	Not described (each item predicts falls)	Four-item tool developed and tested on four medical/surgical units in the US.
The Johns Hopkins Hospital Fall Assessment Tool (revised edition) (Poe et al., 2007)	Moderate risk= 6-13; High risk>13	Seven-item tool developed at Johns Hopkins Hospital. Original tool was tested on 4 medical units and psychiatric unit (Poe, Cvach, Gartrelu, Radzik, & Joy, 2005). The revised tool was tested on the same units (Poe et al., 2007).

Among the seven tools, only the Morse Fall Scale can be found within the SNOMED CT terminology (US National Library of Medicine, 2013a). However, the concept "Morse Fall Risk Assessment" found in SNOMED CT is classified as an 'assessment scale', not a 'clinical finding' that could be used to represent a patient's fall risk status (US National Library of Medicine, 2013a). It is important to note that the recommended cut off score (the score which represents a risk for falls), may differ across settings, which would further limit interoperability and comparison across settings. For example, the St. Thomas Risk Assessment Tool in Falling Elderly Patients (STRATIFY) tool has been studied with both a cut-off score of two and three, and the tool developers encourage validation with each inpatient population before a cut-off score is selected (Oliver et al., 1997). Similarly, researchers in Germany have recommended the use of the Morse Fall Scale with a cut-off of score of 55 (Schwendimann, De Geest, et al., 2006), and Morse recommends that the cut-off score for units may differ depending upon the patient population (2009) . Although 'risk for falls,' exists as a concept in both the NANDA-I and the SNOMED CT standardized terminologies, among the reviewed reports there are no descriptions of its use in patients' clinical records. However, due to the limitations of the literature review, it is possible that studies that described how risk for falls was represented in patients clinical records, such as falls prevention studies, were not reviewed for this research.

Representation and Retrieval of Fall Risk Factors.

According to Healey and Scobie (2007), in acute care, over 400 fall risk factors have been described in the literature. This may be at least partially due to

the variety of terms that have been used to represent fall risk factors in falls research. Confusion and/or agitation, unsteady gait, incontinence or needing frequent toileting, a history of falls, and taking sedatives or sleeping medications are frequently cited as significant fall risk factors (Healey & Scobie, 2007) for patients in acute care. Even among these five, the representation of each risk factor varies across studies. This section will review how these five fall risk factors have been represented in literature reviews and fall prevention guidelines, as well as patients' clinical records across recent fall risk studies. Only fall risk studies that clearly described that the patient fall risk factor data were represented in and retrieved from the clinical record are included in this section. Studies utilizing existing research data sets were included in this section only if the original patient data were collected from the clinical record. In addition to describing how each fall risk factor was represented in the clinical record, this section details how the fall risk factors were retrieved for the research.

Cognitive impairment. Cognitive impairment has been represented in falls risk literature reviews and guidelines as the presence of "agitated confusion" (Gray-Miceli, 2008), "cognitive impairment" (Australian Commission on Safety and Quality in Health Care, 2009; Currie, 2008; Registered Nurses' Association of Ontario, 2011), "altered mental status" (Hook et al., 2008), "short-term memory loss" (Currie, 2008), and "delirium" (Australian Commission on Safety and Quality in Health Care, 2009). Among the reviewed reports, ten fall risk factor studies described how cognitive impairment was represented in the patients' clinical records (see Table 2). Only Brand & Sundararajan (2010) specifically described

that delirium and dementia were represented through a standardized terminology, the International Classification of Disease 10 Australian Modification (ICD-10 AM codes).

Table 2

Representation and Retrieval of Cognitive Impairment

Citation	**Represented in Clinical Record as…(Standardized Terminology)**	**Retrieved from the Clinical Record via…**
(Brand & Sundararajan, 2010)	Delirium (ICD-10 AM Code)[a] Dementia (ICD-10 AM Code)[a]	Clinical data repository
(Capone et al., 2010)	Dementia	Retrieved from the record
(X. L. Chen et al., 2010)	Dementia MMSE[b] Score	Retrieved from the record
(X. Chen et al., 2011)	Dementia MMSE[b]	Retrieved from the record
(M. Ferrari et al., 2012)	Impaired mental status; Confusion; Impaired judgment/lack of safety awareness; change in mental status	Retrieved from the electronic record
(Giles et al., 2006)	Disorientation (memory loss) UOC[c] Confused patient UOC[c]	Clinical data repository
(Lakatos et al., 2009)	Delirium	Retrieved from the record
(Marschollek et al., 2012)	MMSE[a] score	Clinical data repository
(Stenvall et al., 2006)	Dementia Delirium	Retrieved from the record (and patient, family and staff)

Table 2

Representation and Retrieval of Cognitive Impairment

Citation	Represented in Clinical Record as…(Standardized Terminology)	Retrieved from the Clinical Record via…
(Titler et al., 2011)	Senility and organic mental disorders	Secondary analysis (originally retrieved from clinical data repository)

Notes: aICD-10 AM= International Classification of Disease 10 Australian Modification; bMMSE=Mini Mental State Exam; cUOC =Unit of Care (Electronic data coded for patient assessment data and interventions)

Impaired gait. Similarly, impaired gait has been represented with the terms, "gait deficit" (Gray-Miceli, 2008) and "gait problems" (Currie, 2008) in literature reviews and guidelines. While six studies analyzed the association between impaired gait and falls, only three of the reviewed original studies described how impaired gait was represented in the patients' clinical records. Two studies analyzed the impact of impaired gait on falls in acute care, but the data related to gait was obtained through direct patient assessment, without a record review (Corsinovi et al., 2009; Kressig, Herrmann, Grandjean, Michel, & Beauchet, 2008). Another did not clearly describe if the data were obtained directly from the patient or record (Y. C. Chen, Chien, & Chen, 2009). Table 3 describes the terms retrieved from patients' clinical records for the reviewed falls risk research. Brand and Sundararajan (2010) analyzed impaired gait as it was represented through a standardized terminology and retrieved the clinical data through a clinical data repository, while the other two reports only report that the data were retrieved from the record.

Table 3

Representation and Retrieval of Impaired Gait

Citation	Represented in Clinical Record as…(Standardized Terminology)	Retrieved from the Clinical Record via…
(Brand & Sundararajan, 2010)	Ataxia (ICD-10 AM Code)[a]	Clinical data repository
(Capone et al., 2010)	Weak Gait Pattern	Retrieved from the record
(Schmid et al., 2010)	Gait abnormality Ataxia	Secondary analysis (originally retrieved from records)

Note: ICD-10 AM=International Classification of Disease 10 Australian Modification

Urinary incontinence. Urinary incontinence has frequently been cited as a fall risk factor for patients in acute care (Australian Commission on Safety and Quality in Health Care, 2009; Gray-Miceli, 2008) while others cite "increased toileting need" (Currie, 2008). When compared to the terms utilized to represent the other fall risk factors, there was less diversity in the representation of urinary incontinence. Six of the reviewed reports described how urinary incontinence was represented in the clinical record. One report represented urinary incontinence as an item recorded on the facility's safety assessment documentation form (M. Ferrari et al., 2012) and two reports analyzed nursing interventions related to "incontinence management." Three reports described that the data were retrieved from the record, but did not describe whether the data were retrieved electronically or through a manual record review. Two reports

reviewed urinary incontinence data from clinical data repositories. (Giles et al., 2006; Titler et al., 2011). Table 4 reviews how urinary incontinence was represented in the clinical records and how it was retrieved for the research for each of the six studies.

Table 4

Representation and Retrieval of Urinary Incontinence

Citation	**Represented in Clinical Record as…(Standardized Terminology)**	**Retrieved from the Clinical Record via…**
(X. L. Chen et al., 2010)	Urinary Incontinence	Retrieved from the record
(X. Chen et al., 2011)	Urinary Incontinence	Retrieved from the record
(Dharmarajan, Avula, & Norkus, 2006)	Urinary Incontinence	Retrieved from the record
(M. Ferrari et al., 2012)	Patient reports getting wet or soiling self or incontinence	Retrieved from the electronic record
(Giles et al., 2006)	Urinary Incontinence Management (UOC)[a]; Urinary Incontinence (UOC)[a]	Clinical data repository
(Titler et al., 2011)	Urinary Elimination Management	Secondary analysis (originally retrieved from clinical data repository)

Note: aUOC =Unit of Care (Electronic data coded for patient assessment data and interventions)

History of falls. History of falls is one of the most frequently cited fall risk factors among literature reviews and fall prevention guidelines, but the terms utilized to represent a 'history of falls' are not consistent (Australian Commission

on Safety and Quality in Health Care, 2009; Currie, 2008; Institute for Clinical Systems Improvement, 2010; Registered Nurses' Association of Ontario, 2011) . Table 5 describes how the fall risk factor, history of falls, has been represented in the clinical records across recent falls risk research. Brand and Sundararajan (2010) retrieved two variables that represented history of falls. Both were retrieved from the clinical data repository.

Table 5

Representation and Retrieval of History of Falls

Citation	**Represented in Clinical Record as…(Standardized Terminology)**	**Retrieved from the Clinical Record via…**
(Brand & Sundararajan, 2010)	Previous fall history Presenting with a fall	Clinical data repository
(M. Ferrari et al., 2012)	History of falls in past 3 months and/or this admission	Retrieved from the electronic record
(Marschollek et al., 2009)	Fall within past 2 months	Retrieved from the record

Sleeping medications. Among the reviewed reports that discussed the analysis of sleeping medications as a risk factor for falls, nine described reviewing either the clinical record for medications prescribed or administered within a specific time period (Chang et al., 2011; Y. C. Chen et al., 2009; Lamis, Kramer, Hale, Zackula, & Berg, 2012; Rhalimi et al., 2009; Schmid et al., 2010; Shuto et al., 2010; Tanaka et al., 2008). However, it is unclear if the sleeping medications were represented with a standardized terminology in the clinical

record or if the researchers classified these medications after retrieval from the record. One report described that the medications data retrieved was classified using the American Hospital Formulary Service (AHFS) Pharmacological Therapeutic Classification system, but again, it was unclear whether that classification system existed within the clinical record, or if the classification was done after the data were extracted (Lamis et al., 2012). Two reports described retrieving data on the use of specific drugs, such as zolpidem (Chang et al., 2011; Rhalimi et al., 2009), while the others referred to retrieving data on the use of 'hypnotics' and 'sedatives'. In one study, the researchers did not review medication lists, but instead retrieved data on the use of sedatives from the facility's fall risk tool (M. A. Ferrari, Harrison, Campbell, Maddens, & Whall, 2010). One report, (Titler et al., 2011), discussed the retrieval of patient data from the clinical data repository which was classified as "Miscellaneous CNS agents" and another states the medication information was retrieved electronically from the record (Tanaka et al., 2008). Table 6 reviews how sleeping medications were represented in the clinical records and how it was retrieved for the research for each of the nine studies.

Table 6

Representation and Retrieval of Sleeping Medications

Citation	**Represented in Clinical Record as…(Standardized Terminology)**	**Retrieved from the Clinical Record via…**
(Chang et al., 2011)	Zolpidem	Retrieved from the electronic record

Table 6

Representation and Retrieval of Sleeping Medications

Citation	**Represented in Clinical Record as…(Standardized Terminology)**	**Retrieved from the Clinical Record via…**
(Y. C. Chen et al., 2009)	Sedative/Hypnotic	Retrieved from the record
(Lamis et al., 2012)	CNS Agents	Retrieved from the record
(M. A. Ferrari et al., 2010)	Use of sedatives	Retrieved from the electronic record
(Rhalimi et al., 2009)	'Z' Hypnosedative drugs including; zolpidem, zopiclone, zaleplon	Retrieved from the record
(Schmid et al., 2010)	Sedatives	Secondary analysis (originally retrieved from the record)
(Shuto et al., 2010)	Hypnotic Agents	Retrieved from the record
(Tanaka et al., 2008)	Hypnotic	Retrieved from the record electronically
(Titler et al., 2011)	Miscellaneous CNS agents	Secondary analysis (originally retrieved from clinical data repository)

Summary of Representation

While not all of the studies reviewed for this research retrieved fall risk data elements from patients' clinical records, among those that did, few described that the data elements were represented by terms from a standardized

terminology. Disease related fall risk factors, such as delirium and dementia, were represented as International Classification of Disease (ICD) codes in two studies (Brand & Sundararajan, 2010; Lakatos et al., 2009). Another study retrieved admission and discharge diagnoses represented as ICD codes and stated that 'other conditions' were retrieved from the record, without specifically describing how the other conditions were represented (Y. C. Chen et al., 2009). Eight studies did not describe how data on disease and condition related fall risk factors were represented, only that they were retrieved from the record (Chang et al., 2011; X. L. Chen et al., 2010; Rhalimi et al., 2009; Schmid et al., 2010; Shuto et al., 2010; Stenvall et al., 2006; Titler et al., 2011). Lamis et al. (2012), collected data on medication related fall risk factors and while there is no description of how the medications were represented in the clinical record, the researchers categorized each medication with the American Hospital Formulary Service (AHFS) Pharmacologic Therapeutic classification code for analysis. Among the reviewed reports, none of the five fall risk factors were represented with SNOMED CT concepts or NANDA-I diagnoses. Representation of the five most commonly cited fall risk factors within a standardized terminology appears to be limited to ICD codes. The terms described in this section could potentially be represented with standardized terminology. The representational terms identified here through the literature review were used as key words for the terminology mapping methods employed to answer the research questions (see Table 7).

Table 7

Selected Fall Risk Factors and Representational Terms

Fall risk Factor	**Terms used to Represent Falls Risk Factors and 'Risk for Falls' in Clinical Records**
History of Falls	Previous fall history Presenting with a fall History of fall in past 3 months and/or this admission Fall in past 2 months
Impaired Gait	Weak gait pattern Gait abnormality Ataxia
Cognitive Impairment	Impaired mental status Dementia Delirium MMSE score Senility and organic mental disorders Confusion Confused patient Impaired judgment/ lack of safety awareness Changes in mental status Disorientation (memory loss)
Urinary Incontinence	Urinary incontinence Urinary incontinent management Urinary elimination management Pt. reports getting wet or soiling self or incontinence
Sleeping Medications	Sedatives CNS Agents Hypnotics

Note: MMSE=Mini Mental State Examination

Summary on Retrieval

In addition to finding variation among terms utilized to represent fall risk factors and the small number represented with a standardize terminology, there was variation on how fall risk factor data were retrieved for the research. Data for the reviewed studies were retrieved from a variety of sources, including; existing research or quality improvement datasets, electronic clinical data repositories, electronic clinical records, and paper clinical records. Five of the reviewed fall risk studies analyzed an existing dataset (Church, Robinson, Angles, Tran, & Wallace, 2011; Harlein, Halfens, Dassen, & Lahmann, 2011; Hignett, Sands, & Griffiths, 2011; Schmid et al., 2010; Titler et al., 2011). One retrieved all patient fall risk data from a quality assurance database and the patient's electronic medical record (Harrison, Ferrari, Campbell, Maddens, & Whall, 2010). Although Titler et al., (2011) reported using an existing research dataset to complete the study, the data were originally retrieved from nine clinical and administrative data repositories within one health system. Only three other studies retrieved patient data directly from an existing clinical data repository (Brand & Sundararajan, 2010; Giles et al., 2006; Nakai, Akeda, & Kawabata, 2006).

The remaining reviewed reports described retrieving fall risk data from a variety of sources. Tanaka et al. (2008) retrieved data on medication related fall risk factors electronically from the medical record, fall risk status from a nursing fall risk tool recorded on a paper form and other data from post-fall incident reports. Three studies described that fall risk factors were retrieved from the patient's record and the patient (Y. C. Chen et al., 2009; Corsinovi et al., 2009;

Marschollek et al., 2009). One collected data from the clinical record, the patient, the patient's family, and staff members (Stenvall et al., 2006). In two studies, fall risk factors were retrieved from the medical record and the post-fall incident report (Lakatos et al., 2009; Rhalimi et al., 2009). Schwendimann et al., (2008) retrieved data from both the post-fall incident report only and another report simply states that data on fall risk factors were collected (Salameh, Cassuto, & Oliven, 2008). Analysis of data from disparate systems, such as the electronic health record for fall risk factors and the post-fall incident reporting system for the fall outcome data, hampers efficient research. The retrieval of data from a data warehouses provides a

> …more efficient and effective means of accessing data to form hypotheses about disease initiation and progression, search for patterns in certain populations, conduct surveillance studies of new drugs, identify adverse events, improve prescribing practices and, perhaps most importantly, identify potential study candidates for clinical research purposes (Healthcare Information and Management Systems Society, p. 6).

Among the reviewed reports, only Titler et al., (Titler et al., 2011) described the use of multiple data repositories, which included clinical patient data, post-fall incident report data and nursing unit operational data to examine the association between multiple variables and falls in acute care. This type of data analysis is growing as health care systems realize the potential to monitor performance,

analyze patient outcomes and predict trends (Murphy, Wilson, & Newhouse, 2013).

Selection of Fall Risk Factors for this Study.

While there have been over 400 fall risk factors in acute care identified (Healey & Scobie, 2007), the five fall risk factors discussed in the previous section will be selected for this research as it focuses on the representation and retrieval of fall risk factors in the electronic health record, and not the significance of the relationship between the risk factor and falls. However, in order to provide additional rationale for selecting the five fall risk factors, the recent fall risk literature was again reviewed. Only thirty-two of the sixty-five reports reviewed for the previous section on representation were reviewed for findings related to the association between the five fall risk factors and falls in acute care. Thirty-three studies were excluded due to methodological issues, narrow definitions of 'a fall' and lack of appropriate comparison groups for analysis. The following section briefly summarizes the results of the reviewed reports and provides additional rationale for the selection of the five fall risk factors that will be analyzed in this research.

Cognitive impairment. Similar to the other fall risk factors, cognitive impairment is not always specifically defined, but it is cited as a risk factor for falls among patients in acute care (Currie, 2008; Gray-Miceli, 2008; Institute for Clinical Systems Improvement, 2010; Registered Nurses' Association of Ontario, 2011). Table 8 reviews eleven recent original studies that examined the association between falls in acute care and cognitive impairment. Overall,

cognitive impairment continues to be identified as a significant risk factor for falls in acute care; however, as cognitive impairment is represented by a variety of diagnoses, symptoms and assessment scale scores, it is difficult to compare findings across studies.

Table 8

Cognitive Impairment as a Fall Risk Factor

Citation	**Analysis: Variable Representing Cognitive Impairment** ***Results***
(Chang et al., 2011)	Bivariate regression: Cognitive impairment *OR=1.18 (0.62-2.25), p=0.622*
(X. L. Chen et al., 2010)	Chi-square: Dementia *37.1% (recurrent fallers) vs. 33.8% (single fallers) vs. 14.5% (non-fallers), p=0.004;* Binary logistic regression: Dementia *Recurrent fallers- OR=2.0 (1.1-1.39), p=0.030;* Binary logistic regression: MMSE[a] <24 *All Falls-OR=9.6 (2.2-4.1), p=0.002*
(Corsinovi et al., 2009)	Logistic regression: Delirium *RR=3.577 (1.096-11.672), p<0.05;* Chi-square: SPMSQ[b] *10.9% (none/slight impairment) vs. 15.7% (moderate impairment) vs. 9.3% (severe impairment), ns;* Chi-square: Delirium symptoms (per CAM) *27.3% (fallers) vs. 10.7% (non-fallers)*
(Giles et al., 2006)	Multiple regression: Confusion/Confused Patient UOC[c] *OR=1.79 (1.37-2.35), p<0.001*

Table 8

Cognitive Impairment as a Fall Risk Factor

Citation	**Analysis: Variable Representing Cognitive Impairment** ***Results***
(Harlein et al., 2011)	Logistic Regression: Presence of disorientation and/or confusion *OR=2.1 (CI, 1.7-2.7)*
(Large, Gan, Basic, & Jennings, 2006)	Logistic Regression (log TUG): Delirium *OR=2.73 (1.54-4.85), p<0.001*
(Marschollek et al., 2012)	MMSE[a] score on admission did not identify 'high risk' for falls group
(O'Connell, Baker, Gaskin, & Hawkins, 2007)	T-test: Bedside confusion *0.7±1.2 (fallers) vs. 0.3±0.9 (non-fallers), p=0.31;* T-test: Orientation *0.3±0.5 (fallers) vs. 0±0.0 (non-fallers), p=0.08*
(Salameh et al., 2008)	Logistic regression: Confusion or altered mental status (moderate) *OR=1.24 (0.75-2.06), p=0.41* Logistic regression: Confusion or altered mental status (Severe) *OR=1.56 (0.86-2.85), p=0.15*
(Stenvall et al., 2006)	Univariate Cox regression: Dementia *HRR=3.57 (1.53-8.31), ns in multiple regression;* Multiple Cox regression: Delirium after day 7 *HRR=4.62 (1.24-16.37)*
(Titler et al., 2011)	Correlation: Senility and organic mental disorders *OR=1.59, p=0.0245*

Notes: aMMSE=Mini Mental Status Exam; No significance testing result described; bSPMSQ=Short Portable Mental Status Questionnaire; ns=Not Significant; cUOC =Unit of Care (Electronic data coded for patient assessment data and interventions);

Impaired gait. Gray-Micelli (2008) cite that gait and balance impairment is a risk factor for falls among older adults in acute care while others cite gait problems as an impairment of mobility (Institute for Clinical Systems Improvement, 2010). Impaired gait and imbalance are often grouped together in fall risk studies and whether or not these are two distinctly different fall risk factors remains a question, but for this research, only impaired gait was selected as a significant fall risk factor. Among the reports reviewed for this research, five original studies examined impaired gait as a fall risk factor in acute care. Again, impaired gait was represented by a wide variety of terms with three evaluating multiple measures of gait impairment (Kressig et al., 2008; Marschollek et al., 2009; Schmid et al., 2010). Table 9 reviews the findings of the reviewed studies related to the association between impaired gait and falls in acute care.

Table 9

Impaired Gait as a Fall Risk Factor

Citation	**Analysis: Variable Representing Cognitive Impairment** ***Results***
(Y. C. Chen et al., 2009)	Descriptive: Gait instability *14.85% (fallers) and 9.41 (non-fallers), p=0.13*
(Kressig et al., 2008)	Cox regression: Stride time variability while walking *OR=13.3 (1.6-1113.6), p=0.018* Cox regression: Stride time while walking and counting backwards *OR=8.6 (1.9-39.6), p=0.006*
(Corsinovi et al., 2009)	T-test: Tinetti Gait score *5.04±4.57 (fallers) vs. 4.90±5.04 (non-fallers), p<0.001;*

Table 9

Impaired Gait as a Fall Risk Factor

Citation	**Analysis: Variable Representing Cognitive Impairment** ***Results***
(Marschollek et al., 2009)	T-test: Pelvic sway *0.416 (fallers) vs. 0.538 (non-fallers), p=0.042;* T-test: Periodicity of gait *0.550 (fallers) vs. 0.552 (non-fallers), p=0.742;* T-test: Seconds per step *1.21 (fallers) vs. 1.31 (non-fallers), p=0.301;* T-test: Step length *0.095 (fallers) vs. 0.130 (non-fallers), p=0.004;* T-Test: # of steps in TUG[a] *64.1 (fallers) vs. 47.4 (non-fallers), p=0.061*
(Schmid et al., 2010)	Chi-square: Gait abnormality *71% (fallers) vs. 70% (non-fallers), p=0.86;* *Chi-square:* Ataxia *29% (fallers) vs. 27% (non-fallers), p=0.72*

Note: aTUG=Timed up and Go;

Urinary incontinence. As previously discussed, urinary incontinence has been cited as a fall risk factor among patients in acute care (Australian Commission on Safety and Quality in Health Care, 2009; Gray-Miceli, 2008). An increased need for toileting has also been cited (Currie, 2008). Researchers continue to study both the condition of urinary incontinence and the intervention to manage urinary incontinence in fall risk studies. Table 9 describes three recent original studies reviewed for this research. Urinary incontinence and the

management of urinary incontinence continue to be identified as a risk factor for falls in acute care. Table 10 reviews the findings of the reviewed studies related to the association between urinary incontinence and falls in acute care.

Table 10

Urinary Incontinence as a Fall Risk Factor

Citation	**Analysis: Variable Representing Cognitive Impairment** ***Results***
(X. L. Chen et al., 2010)	Binary Logistic Regression: Incontinence *OR=4.5 (1.8-11.2), p=0.00*
(Giles et al., 2006)	Multiple regression: Urinary Incontinence Management UOC[a] *OR=6.63 (3.63-12.11)* Multiple regression: Urinary Incontinence UOC *OR=1.54 (1.18-2.01), p=0.001*
(Titler et al., 2011)	Urinary elimination management

Note: aUOC=Unit of Care (Electronic data coded for patient assessment data and interventions)

History of falls. History of falls continues to be a frequently cited risk factor for falls in acute care (Australian Commission on Safety and Quality in Health Care, 2009; Currie, 2008; Gray-Miceli, 2008; Hook et al., 2008; Institute for Clinical Systems Improvement, 2010; Registered Nurses' Association of Ontario, 2011). Among the reviewed reports, seven studies analyzed 'history of falls' as a fall risk factor among patients in acute care. Five studies found that a 'history of falls' was significantly related to falls in acute care. Differences in operational definitions for 'history of falls' and study populations were noted. One study that did not find a positive history of falls significantly different between fallers and non-fallers defined history of falls as ordinal categories (no falls, 1 fall,

2 or more falls) and perhaps would have found significance if the history of falls was dichotomized to yes or no (Corsinovi et al., 2009). Table 11 presents the results of each of the studies.

Table 11

History of falls as a Fall Risk Factor

Citation	**Analysis: Variable Representing Cognitive Impairment** ***Results***
(Y. C. Chen et al., 2009)	Multivariate regression: Greater than 1 fall in past year *OR=5.05 (2.6-9.78), p<0.001*
(Corsinovi et al., 2009)	Chi-square: Number of falls in past 6 months *10.7% (non-faller); 10.4% (1 fall); 18.5% (2 or more falls), ns*
(Marschollek et al., 2009)	T-test: Fall within past 2 months *0.81 (fallers) vs. 0.56 (non-fallers) (p=0.012)*
(O'Connell et al., 2007)	Chi-Square and Cramer's: Fall in past 12 months *V Ø=0.1, p=0.05*
(Robey-Williams et al., 2007)	Chi-square: Fall in past 3 months *Statistic not reported; (p=0.0158) and Fischer's Exact Test (p=0.0212)*
(Salameh et al., 2008)	Multivariate regression: Fall within past 3 months *OR=3.8 (2.65-5.53), p<0.0001*
(Stenvall et al., 2006)	Cox univariate regression: Fall in that last month *HRR=2.04 (1.01-4.15)* Multiple regression: Fall in that last month *ns*

Note: ns=not significant

Sleeping medications. Sedatives and hypnotics have been cited as risk factors for falls (Currie, 2008; Institute for Clinical Systems Improvement, 2010)

and their association with falls in acute care continues to be studied. Researchers have studied both individual drugs and groups of drugs, but few reports described which medications were included in each group, which may account for the conflicting findings. Although not all reports find sleeping medications to be significantly associated with falls in acute care, most continue to find evidence to support the use of sleeping medications as a risk factor for falls in acute care. Table 12 describes the findings of the reviewed reports.

Table 12

Sleeping Medications as a Fall Risk Factor

Citation	**Analysis: Variable Representing Cognitive Impairment** ***Results***
(Y. C. Chen et al., 2009)	Multivariable regression: Newly prescribed sedatives/ hypnotics on admission *OR=1.86 (1.1-3.14), p=0.02*
(Chang et al., 2011)	Bivariate regression: *Zolpidem* *OR=2.38 (1.04-5.43), p=0.040*
(Lamis et al., 2012)	Backward Stepwise Elimination Regression: CNS agents *OR=1.4 (1.09-1.71)*
(Rhalimi et al., 2009)	Multivariate Regression: Zolpidem *OR=2.59 (1.16-5.81), p=0.02*
(Schmid et al., 2010)	Backward Elimination Regression: Sedatives *None found to be significant, statistic not reported*
(Shuto et al., 2010)	Conditional logistic regression (For all ages):Hypnotics *OR=2.44 (1.32-4.51), p=0.004* Conditional logistic regression (For all ages): Zopiclone *OR=4.2 (1.55-11.40), p=0.005* Conditional logistic regression (For ages >75): Zopiclone *OR=5.40 (1.63-17.93), p=0.006*

Table 12

Sleeping Medications as a Fall Risk Factor

Citation	**Analysis: Variable Representing Cognitive Impairment** ***Results***
(Tanaka et al., 2008)	Multiple logistic regression: Hypnotics *OR=1.66 (0.94-2.87), p=0.072*
(Titler et al., 2011)	General effect estimates: Miscellaneous CNS Agents *ns*

Standardized Terminologies in Electronic Health Records (EHRs)

The development of standardized terminologies has flourished over the past twenty years (Lundberg et al., 2008) and representing clinical data in the electronic health record through standardize terminologies is considered to be 'essential' according to the National Library of Medicine (NLM) (National Library of Medicine (U.S.). Board of Regents, 2006). The call to employ standardized terminologies within electronic health records to represent patient clinical data is echoed by many (Elkin et al., 2010; Hovenga, Garde, & Heard, 2005; Lang, 2008). Electronic data representation, constructed with standardized terminologies, has the potential to not only support evaluation of practice and quality across settings (Rutherford, 2008), but can also provide the necessary building blocks with which clinical decision tools could be created (Lang, 2008). The Long Range Plan for 2006-2016 published by the National Library of Medicine (NLM) includes a goal to achieve, "Integrated biomedical, clinical, and public health information systems that promote scientific discovery and speed the translation of research into practice" (National Library of Medicine (U.S.). Board

of Regents, 2006, p. 41). More specifically, the NLM seeks to “Promote development and use of advanced electronic representations of biomedical knowledge in conjunction with electronic health records” (National Library of Medicine (U.S.). Board of Regents, 2006, p. 44).

However, the representation of nursing assessment, diagnosis, planning, and evaluation has not been consistently integrated as discrete data elements within the electronic health record (Lang, 2008; Westra, Delaney, Konicek, & Keenan, 2008). A recent review related to the structure and content of electronic health records (EHRs), found that only four of 89 reports described nursing data represented in a standardized terminology (Hayrinen, Saranto, & Nykanen, 2008). According to Hayrinen et al. (2008), North American Nursing Diagnosis Association (NANDA) concepts were described in four reports, Nursing Interventions Classification (NIC) concepts in three, Nursing Outcomes Classification (NOC) concepts in one and International Classification of Nursing Practice (ICNP) concepts in one. The researchers who conducted this review concluded that, “…in EHR development work, nursing information systems and the patient’s role in producing data for EHR have not been taken into account” (Hayrinen et al., 2008).

Integration of standardized terminologies into EHRs has also been limited by the structure of the individual clinical information system. In 2003, Aspirus Hospital in Wausau, Wisconsin, implemented the EPIC electronic health information system. Before implementation, nursing leaders selected the SNOMED CT terminology to represent nursing practice, but the version of EPIC

that was to be implemented was not able to support the SNOMED CT coding (Klehr, Hafner, Spelz, Steen, & Weaver, 2009). Instead, the NANDA-I, Nursing Interventions Classification (NIC), Nursing Outcomes Classification (NOC) terminologies were chosen, but the nursing leadership at Aspirius then discovered that the NOC rating scale and the activities listed under each NIC intervention could not be built as specified in the terminology (Klehr et al., 2009).

Despite the ongoing challenges, where standardized terminologies have been embedded into the electronic health record, researchers are retrieving discrete patient data to evaluate patient outcomes and add to nursing knowledge. Westra et al., (2011) completed a study on urinary and bowel incontinence among patients from 15 Home Health agencies. The patient specific assessment and outcome data elements were recorded using the Outcome and Assessment Information Set (OASIS) and interventions were recorded using the Omaha System. For this study, the researchers analyzed hundreds of individual patient characteristics (assessments) and 265,966 nursing interventions to identify predictors of improvement in bowel and urinary incontinence outcomes (Westra et al., 2011). By analyzing the assessment, intervention and outcome data simultaneously, this study demonstrates the value of research with data recorded as discrete, electronic data coded in standardized terminology. Head et al. (2011) studied the most frequently applied NADNA-I diagnoses, NIC interventions and NOC outcomes among 451 patients hospitalized with pneumonia in three hospitals. Each hospital had electronic documentation with the NANDA-I, NIC and NOC terminologies and while not all, most data were retrieved electronically

through the clinical information system (Head et al., 2011). This study demonstrated the benefits of interoperability, as two of the community hospitals were part of the same health system, while the third was a different health system, with a different clincial information system vendor (Head et al., 2011).

Standardized Terminology

The use of standardized terminologies to represent the current knowledge about fall risks in acute care would not only increase the interoperability across clinical information systems, but would also fill a vital gap needed to advance the science related to falls prevention. Standardized nursing terminologies have been called the 'building blocks' that will allow nurses to assess their impact on patient outcomes (Jones et al., 2010) but those 'building blocks' are not always embedded in clinical information systems. The development and dissemination of terminologies to classify nursing practice has been a growing focus of nursing researchers and practitioners. According to Park and Cho (2009), the American Nurses Association (ANA) recognizes terminologies suitable for describing and classifying nursing practice which include: (1) the Nursing Minimum Data Set (NMDS); (2) The Nursing Management Minimum Data Set (NMMDS); (3) Nursing Interventions Classification (NIC); (4) Nursing Outcomes Classification (NOC); (5) North American Nursing Diagnosis Association-International (NANDA-I); (6) Omaha System; (7) Clinical Care Classification (CCC); (8) Patient Care Data Set (PCDS); (9) Perioperative Nursing Data Set (PNDS); and (10) International Classification for Nursing Practice (ICNP). SNOMED CT, Logical Observation Identifiers Names and Codes (LOINC) and Alternative Billing Codes (ABC) also

represent nursing knowledge but are considered multidisciplinary terminologies. Each terminology was developed for a specific purpose and many were developed to be used within a specific context (Lundberg et al., 2008). These terminologies have been around for a little more than a quarter of a century, but the implementation of standardized terminology into nursing practice and documentation continues to be challenging. For the purposes of this research, five terminologies are reviewed, NANDA-I (Taxonomy II), SNOMED-CT, ICD, Aurora Risk Falls Constraint Group found in the U.S. Health Information Knowledgebase (USHIK) and the American Hospital Formulary Service (AHFS) Pharmacological Therapeutic Classification.

NANDA-I (Taxonomy II). The North American Nursing Diagnosis Association (NANDA) was officially founded in 1982 but began as a task force in 1973 at the First National Conference on Classification of Nursing Diagnosis (NANDA International, 2012). In 2002, NANDA became the North American Nursing Diagnosis Association-International (NANDA-I) but their mission remained the same, to represent nursing knowledge through the development, dissemination and use of nursing diagnosis through standardized terminology (NANDA International). Taxonomy II, the most current edition, has 13 domains based on Gordon's Functional Health Pattern Framework, with one of the patterns being split into two and the addition of a growth and development domain (Herdman, 2012). NANDA-I's Taxonomy II is structured to comply with the International Standards Organisation (ISO) nursing reference model, the National Library of Medicine (NLM) recommendations on health care

terminologies, and is included in the SNOMED-CT terminology (Herdman, 2012). Taxonomy II was constructed on a seven axes model. The seven axes include; diagnostic focus, subject of diagnosis, judgment, location, age, time, and status of diagnosis (Herdman).

SNOMED CT. Systematized Nomenclature for Medicine Clinical Terms (SNOMED CT) is a multidisciplinary, clinical terminology developed by the College of American Pathologists (CAP) and is currently owned and managed by the International Health Terminology Standards Development Organisation (U.S. National Library of Medicine, 2013). SNOMED CT is a multi-hierarchical terminology that includes hundreds of thousands of clinical terms that can represent virtually any clinical concept, including those used in nursing (Richesson, Fung, & Krischer, 2008).

ICD/ICD-CM. The International Classification of Disease (ICD) and the International Classification of Diseases, Clinical Modification (ICD-CM) are examples of standardized terminologies utilized to classify diseases (Centers for Disease Control and Prevention, 2012a). ICD codes are used to classify mortality data, while ICD-CM codes are used to classify morbidity from hospital and physician records as well as from the National Center for Health Statistics (NCHS) survey data (Centers for Disease Control and Prevention, 2012a).

Aurora "Risk for Falls" Constraint Group (USHIK). USHIK is a "registry and repository of health-care related data, metadata, and standards" (U.S. Department of Health and Human Services, 2013). USHIK is a publicly

accessible data repository that allows health care facilities, researchers, federal agencies, standards developers and other to view, download, and use data element and value sets. The Aurora "Risk for Falls" constraint group contains 30 data elements and was submitted to USHIK in 2010 by UW Milwaukee (United States Health Information Knowledgebase, 2010).

American Hospital Formulary Service (AHFS). The AHFS Pharmacological Therapeutic Classification is a four-tier, hierarchical classification system registered with the HL7 Object Identifier Definition (OID) Registry (American Society of Health-System Pharmacists, 2013b; Health Level Seven International, 2013). Each medication is labeled with class number and class description, with increasing levels of specificity (American Society of Health-System Pharmacists, 2013b).

Conceptual Framework: Knowledge Based Nursing Initiative

The Aurora, Cerner, University of Wisconsin-Milwaukee (ACW) Knowledge Based Nursing Initiative (KBNI) framework supports the translation of evidence-based nursing practice into an electronic format, built as actionable items into a clinical decision support system that can subsequently be extracted electronically not only to inform practice and quality measures, but to provide further data for research (Lang, 2008). The framework is composed of six components: (1) knowledge development; (2) knowledge representation; (3) prototype development; (4) live environment implementation including clinical decision support; (5) data extraction and analysis using data from the clinical

repository; and (6) dissemination of the results (Lang, 2008; University of Wisconsin, 2012).

The first component, knowledge development, is completed through a five step process which includes: (1) the selection of a phenomena of concern (i.e., falls) through a prioritization process; (2) conducting a literature search; (3) analyzing, synthesizing the evidence from the literature; (4) creating recommendations for practice as 'actionable' items (in machine readable format) and; (5) designing operational and research outcomes within a standardized terminology that will ultimately be used to monitor quality, practice and inform research (Kerfoot et al., 2010; Lang, 2008). The knowledge is then not only embedded as actionable items into the clinical information system through components three and four, but also stored as referential knowledge in a web-based system that is accessible to the end user, component two (Lang, 2008). Figure 1 shows the KBNI framework.

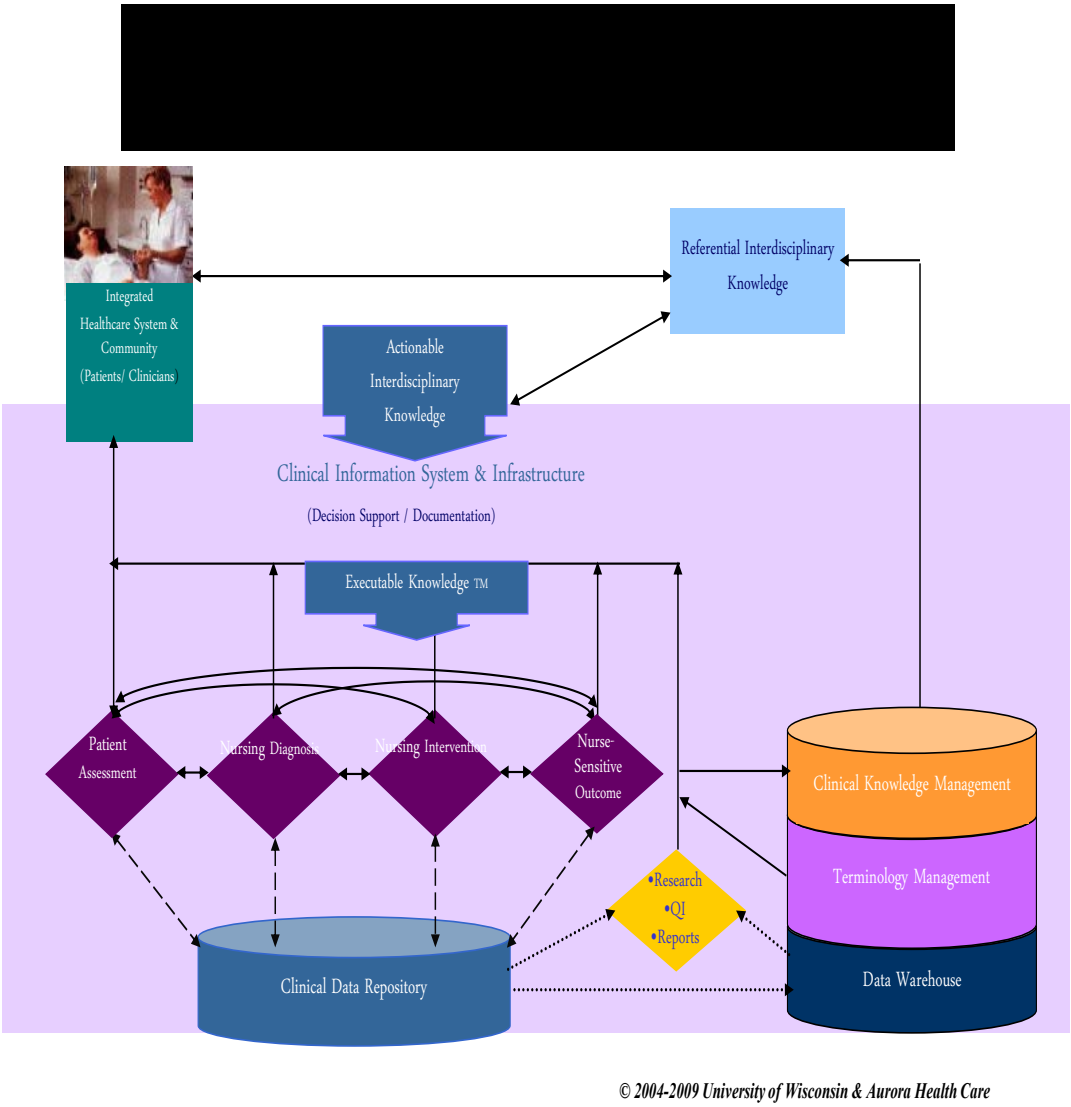

Figure 1 Knowledge-Based Nursing Initiative

Hook, Devine, & Lang (2008) described how this framework was used to develop a fall risk assessment and tailored interventions plan that were implemented into the information and clinical decision support system in a local health system. The report focused on the knowledge development and knowledge representation components of the framework with a review of the

literature related to falls in acute care, medical-surgical settings and resultant recommendations that were embedded into the clinical information system with clinical decisions support tools (Hook et al., 2008). The report did not include outcome data but clearly described that data fields were built in order to capture patient characteristics, assessments, interventions and outcomes, which will allow for evaluation of the newly embedded fall risk elements.

The KBNI framework has several advantages over the other frameworks used to study falls. The basis for this framework is knowledge and as science progresses, that knowledge has to be adaptable and updated and the KBNI framework supports this iterative process. In addition, the framework is keeping up with the expectations of the nation, through the design of 'actionable', machine-coded elements that are in standardized terms and that will support the meaningful use of the electronic health record. The framework is also aligned with the goals of nursing informatics research. In a recent publication describing the nursing informatics goals for 2008-2018, one of the key messages was related to the use of translational research (Bakken, Stone, & Larson, 2012). One sentence in the publication further supports the use of the KBNI framework, "*Beyond comparative effectiveness research, there is a need to build the science of dissemination and implementation so that practices found to be more effective in real-world settings are adopted*" (Bakken et al., 2012). Finally, the KBNI framework supports the nursing profession and not only allows for increased recognition of nursing's independent contributions to patient care outcomes, but allows the creation of a process by which the nursing profession can iteratively

add to the generalizable professional knowledge (Kerfoot et al., 2010; Lang et al., 2006).

The KBNI framework was utilized to guide this study to answer the question, “to what extent are selected fall risk factors and the problem, ‘risk for falls,’ represented and retrievable in the patient’s electronic health record in acute care.” This study focused on components two, knowledge representation, and component five, extraction of data for analyses. This study describes the use of both standard and non-standardized terms to represent the problem, ‘risk for falls,’ and the five selected fall risk factors in the clinical information system and analyzed the terms that were extracted from the electronic data warehouse.

Summary

In summary, determining a patient’s ‘Risk for Falls’ in acute care is not based on any consistently applied tool or set of risk factors. As discussed in the review of the literature, ‘risk for falls,’ can be represented as a nursing diagnosis (problem) defined as a risk “for increased susceptibility to falling that may cause physical harm” (Herdman, 2012, p. 285) or a SNOMED CT concept but no reports that described ‘risk for falls,’ were represented with either of these standardized terms. Likewise, among the reviewed repots, few fall risk factors retrieved from clinical records in acute care were represented with a standardized terminology. With a variety of terms to represent each of the five fall risk factors and the problem, ‘risk for falls,’ comparison of findings across studies is limited.

Standardized terminologies have existed for decades (Westra et al., 2008) with some, (i.e. ICD), in existence for over 100 years (World Health Organizaiton, 2013). However, the use of standardized terminologies to represent nursing collected data that is electronically retrievable is limited (Lang, 2008). Hence, this research seeks to identify to what extent, selected fall risk factors and the problem, 'risk for falls,' are represented and retrievable in the patient's electronic health record in one acute care organization.

Chapter 3: Methods

The purpose of this research was to identify to what extent, selected fall risk factors and the problem, 'risk for falls' are represented and retrievable in the patients' electronic health record in one acute care organization. Specifically, this study seeks to answer three questions:

1) How can the selected fall risk factors and problem, 'risk for falls' be represented through selected standardized terminologies?

2) How are the selected fall risk factors and problem, 'risk for falls' represented in a clinical information system?

3) Which of the selected fall risk factors and problem, 'risk for falls' can be retrieved from the electronic health record?

Setting

The research was conducted at a local health care system, utilizing the electronic health record data from among patients discharged from one of seven medical/surgical units. The local health care system is a small, mid-western, non-profit, health-system with two hospitals. Each hospital offers inpatient, ambulatory, and outpatient care. The first hospital has eleven inpatient departments offering medical, surgical, critical care, obstetrics, gynecological, pediatric, and psychiatric services and serves approximately 16,000 inpatients per year. The second hospital serves just over 3,000 inpatients per year and has five inpatients departments offering medical, surgical, critical care, obstetrics, gynecological and pediatric services. The seven medical/surgical units were

chosen because a majority of the reviewed fall risk research was conducted in inpatient medical/surgical departments.

Research Question One: How can the Selected Fall Risk Factors and the Problem, 'Risk for Falls' be Represented through Selected Standardized Terminologies?

Design. The first research question was completed using terminology mapping. Other nurse researchers have used similar mapping methods to match evidence-based practice recommendations from the literature to standardized terminologies (Dontje & Coenen, 2011; Kerfoot et al., 2010). For this research, each of the five selected fall risk factors and the problem, 'risk for falls,' were mapped to standard terms found in the following terminologies: ICD-9, SNOMED-CT, NANDA-International (Taxonomy II), the Aurora Risk for Falls Constraint group published in USHIK, and the AHFS Pharmacological Therapeutic Classification. Through the literature search, terms that represented each of the five falls risk factors and the problem, 'risk for falls,' were recorded and used as 'key words' to search for lexical matches to terms in each of the five standardized terminologies. Each lexically matching (term to term) standardized term was evaluated for appropriates for inclusion, based on the researchers clinical knowledge. Table 13 displays the representational terms from the evidence used as key words.

Table 13

Representational Terms as Key Words

General Term	**Representational Terms used as "Key Word" for Lexical Matching**
Risk for Falls	Potential for falls Low, medium, high risk for falls Morse score 45 or greater STRATIFY score 2 or greater
History of Falls	Previous fall history Presenting with a fall History of fall in past 3 months and/or this admission Fall in past 2 months
Impaired Gait	Weak gait pattern Gait abnormality Ataxia
Cognitive Impairment	Impaired mental status Dementia Delirium MMSE score Senility and organic mental disorders Confusion Confused patient Impaired judgment/ lack of safety awareness Changes in mental status Disorientation (memory loss)
Urinary Incontinence	Urinary incontinence Urinary incontinent management Urinary elimination management Pt. reports getting wet or soiling self or incontinence
Sleeping Medications	Sedatives CNS Agents

Table 13

Representational Terms as Key Words

General Term	Representational Terms used as "Key Word" for Lexical Matching
	Hypnotics

Note: MMSE=Mini Mental State Examination

The five terminologies were selected because the review of literature indicated that intrinsic falls risk factors include co-morbid diseases, historical and physical conditions that are typically reviewed as part of the nursing assessment and specific medication classes (Currie, 2008). All continue to be substantiated as significant fall risk factors through recent research. The following section outlines the terminology mapping process used for each of the five terminologies.

NANDA-I. The NANDA International Nursing Diagnosis: Definitions and Classifications 2012-2014 (Herdman, 2012) text was searched for nursing diagnoses that matched the key words from Table 12. Each NANDA-I diagnosis is constructed with a label, a unique five-digit code, a definition, a list of defining characteristics, and a list of related factors. The key words were used to identify lexical matches in the diagnosis label, diagnosis definition, or defining characteristics.

SNOMED CT and ICD-9 CM. The National Cancer Institute (NCI) Term Browser (National Cancer Institute, 2013) was used to search for SNOMED-CT and ICD-9 terms that matched the key words from Table 12. The NCI term browser is located at www.nciterms.nci.nih.gov/ncitbrowser. The NCI term browser allows the user to narrow or widen the search with the application of

filters. The user can select one of the following filters: 1) Exact match; 2) Begins with; 3) Contains. A second filter allows the user to select one of the following filters: 1) Name/Code; 2) Property; and 3) Relationship (National Cancer Institute, 2013). As the representational terms from the evidence were used for lexical matching, the filters 'contains' and 'name/code' were applied for the search of the SNOMED CT and ICD-9 terminologies. The key words and the lexical variants were used to search. Only preferred terms were selected for the mapping, no entry terms were selected.

The Aurora "Risk for Falls" Constraint Group. The Aurora "Risk for Falls" Constraint Group located in the USHIK database was searched for potential matching terms. The U.S. Heath Information Knowledgebase (USHIK) website at (http://ushik.ahrq.gov/index.jsp?enableAsynchronousLoading=true) was accessed and the Aurora "Risk for Falls" Constraint Group data elements were downloaded for review. The constraint group data set contained 30 data elements. Each data element included, among other details, the data element name, identification number, and permissible values (United States Health Information Knowledgebase, 2010). The data element name and permissible values were searched for lexical matches.

AHFS. The American Hospital Formulary Service (AHFS) Pharmacological Therapeutic Classification text was searched to map the three medication classes found to be significant fall risk factors in acute care (American Society of Health-System Pharmacists, 2013a). The AHFS Pharmacological Therapeutic Classification is a four-tier, hierarchal classification registered with

the HL7 Object Identifier Definition (OID) Registry (American Society of Health-System Pharmacists, 2013b; Health Level Seven International, 2013). Each medication is labeled with class number and a class description, with increasing levels of specificity (American Society of Health-System Pharmacists, 2013b).

Once the mapping was completed, three UW Milwaukee faculty members with experience in terminology mapping provided expert review and feedback on the proposed mapping. The faculty members recommended that the method of lexical mapping be clear. This feedback resulted in a second review of the mapped concepts by the researcher to ensure appropriate lexical mapping. Consequently, two originally mapped ICD-9 CM codes were dropped because the lexical matches were mapped to the synonyms of the diagnosis name and not the name itself. For example, the search with the key word 'ataxia' resulted in the return of the diagnosis, 'lack of coordination,' because ataxia was listed as a synonym.

Research Question Two: How are the Selected Fall Risk Factors and Problem, 'Risk for Falls' Represented in a Clinical Information System?

Design. The second research question was also completed through terminology mapping. Research question number two was completed using the standard terms mapped in question one. The study site's simulated clinical information system (the simulated system is a copy of the actual clinical information system, but without real patient data) was used to search for matching terms recorded in discrete fields. Data recorded in narrative text (e.g. progress notes, nursing notes, history and physical reports) were not searched

for potential matches. The researcher worked with staff from the local organization to locate the mapped standardized terms within the study site's clinical information system. In addition, the key words were used to locate non-standardized, lexical matching terms that were specific to the study site. Once the standard and non-standardized terms were located in the clinical information system, the researcher worked with a clinical information system analyst and data warehouse analyst to identify the associated 'machine-readable codes' that would be required to extract data from the electronic data warehouse.

Research Question Three: Which of the Selected Fall Risk Factors and Problem, 'Risk for Falls' can be Retrieved from the Electronic Health Record?

Design. A retrospective, descriptive study design was utilized to identify which fall risk factors and if the problem, 'risk for falls,' were retrievable from patient data contained within the electronic data warehouse.

Sampling methods. The unit of analysis for this study was an episode of care. An episode of care is defined as the time from a patient's admission to the hospital inpatient department to the time of discharge. Only patient data elements contained within the study site's electronic data warehouse were requested for this research. Data from all patients discharged from one of the study site's seven medical/surgical units, for the period of May 10, 2013 through June 10, 2013 were included in the sample. The estimated sample for this study was projected to include between 600-800 patient episodes of care.

Inclusion and exclusion criteria. This research focused on the representation and retrieval of fall risk factors and the problem, 'risk for falls' as data elements in the electronic health record for all patients, not only fall risk factors among patients who fell. The data requested for this research included data from patients who were 18 years old or older at the time of the data extraction. Episodes of care lasting less than 24 hours were excluded because the admission documentation at the research site is required to be completed within 24 hours of admission, therefore, patients with a stay of less than 24 hours, may not have fall risk factors or 'risk for falls' recorded. Each fall risk term that was available in the electronic data warehouse was extracted, using an electronic query, only if it was present in the patient's electronic health record during the hospital episode of care.

Testing the data extraction method. Prior to requesting the patient data for research question three, the researcher worked with the data warehouse analyst to test the method of data extraction. The researcher requested the data and corresponding medical record numbers of three episodes of care who meet the inclusion/exclusion criteria. Using the medical record number, the researcher visually compared the patient's electronic health record to the data that was retrieved during the electronic data extraction, for the corresponding hospital episode, to verify that the data matched. The data matched 100%. Each term retrieved during the electronic data extraction matched the patient's electronic health record for the given hospital episode. After verification, the dataset for method testing (n=3) was destroyed.

Data collection. Once the method of data extraction was verified with the small limited data set, the researcher requested a de-identified data set for the entire sample population. The coded data elements that represent the fall risk factors and the problem, 'risk for falls' were retrieved from the electronic data warehouse by a data warehouse analyst at the study site.

Data management. The data warehouse analyst, exported the de-identified data set to an Excel® file and sent it via secure email to the researcher. The researcher reviewed the excel file for any obvious errors and imported it into SPSS (Version 17) for further review and analysis.

Data analysis. Each row in the SPSS file represented the data from unique hospital episode for a single patient. Data were analyzed using SPSS (Version 17). Data were first reviewed for any obvious errors and the SPSS row count was double-checked against the original excel file. The row counts matched. There were 995 rows of data in both the original excel file and the SPSS file. Frequencies of each data element were analyzed for each variable to identify any coding errors. Descriptive data were analyzed for each retrieved term.

Protection of human subjects. The institutional review board at the study site and the University of Wisconsin-Milwaukee reviewed and approved this research. As this research would not have been possible if a written consent were required, a waiver of authorization was received. The data set that included the patient's medical record numbers, for the method testing, was destroyed after

the method of data extraction was verified. For each of the patient records accessed to verify the method of data extraction, a ‘quick disclose’ was completed in the patient’s electronic health record to document the data reviewed. The researcher maintained all data and completed all analysis on a password-protected computer in a locked office.

Chapter 4 Findings

The purpose of this study was to identify to what extent selected fall risk factors and the problem, 'risk for falls,' were represented and retrievable in the patient's electronic health record in acute care. Specifically, this study sought to answer three questions: 1) How can the selected fall risk factors and problem, 'risk for falls' be represented through selected standardized terminologies? 2) How are the selected fall risk factors and problem, 'risk for falls' represented in a clinical information system? and 3) Which of the selected fall risk factors and problem, 'risk for falls' can be retrieved from the electronic health record? In this section, the results of each of the three research questions are presented.

Research Question One: Representation of Fall Risk Factors and 'Risk for Falls' with Standardized Terminology

The five terminologies were selected because the review of literature indicated that intrinsic falls risk factors include co-morbid diseases, historical and physical conditions that are typically reviewed as part of the nursing assessment and specific medication classes (Currie, 2008). Additionally, the five terminologies represent a mixture of domain specific terminologies (NANDA-I, ICD-9 CM, and AHFS), a multidisciplinary terminology (SNOMED CT), and a site-specific terminology (Aurora "Risk for Falls" Constraint Group), which provided for complete mapping of all terms. This section describes the results of the terminology mapping of each of the five selected fall risk factors and the problem, 'risk for falls,' to each of the five selected terminologies.

NANDA-I. The North American Nursing Diagnosis Association-International (NANDA-I), describes that a nursing risk diagnosis is a "clinical judgment about human experience/responses to health conditions/life processes that have a high probability of developing within an individual…" and is "supported by risk factors that contribute to the vulnerability" (Herdman, 2012, p. 341). The problem, 'risk for falls' mapped to the NANDA-I diagnosis "Risk for Falls" (00155) (Herdman, 2012). Each of the other five fall risk factors, except 'history of falls,' and 'sleeping medications' mapped to one or more NANDA-I diagnosis. However, because these two risk factors represent patient data and not a "clinical judgment about human experience/response to health conditions/life process…" (Herdman, 2012, p. 341), it is logical that no matching diagnoses were found. 'Impaired gait' did not exist as a diagnosis. However, among the defining characteristics for the diagnosis, 'Impaired mobility,' the term 'gait changes' was identified and accepted as a positive match. The complete results of the terminology mapping to NANDA-I diagnosis are displayed in Table 14.

Table 14

Risk for Falls and Fall Risk Factors Mapped to NANDA-I

General Term	Representational Terms from Evidence	NANDA-I Terms (Codes)
Risk for Falls	Potential for falls; Low, medium, high risk, Morse score 45 or greater; STRATIFY score 2 or greater	Risk for falls (00155)
History of Falls	Presenting with a fall; History of fall in past 3 months and/or this admission; Fall in past 2 months	NA
Impaired Gait	Weak gait pattern; Gait abnormality; Ataxia	Impaired Physical Mobility (00085)
Cognitive Impairment	Impaired mental status; Dementia; Delirium; MMSE score; Senility organic mental disorders; Confusion; Confused patient; Impaired judgment/ lack of safety awareness; Changes in mental status; Disorientation (memory loss)	Acute Confusion (00128) Chronic Confusion (00129) Impaired Memory (00131)

Table 14

Risk for Falls and Fall Risk Factors Mapped to NANDA-I

General Term	Representational Terms from Evidence	NANDA-I Terms (Codes)
Urinary Incontinence	Urinary incontinence; Urinary incontinence management; Urinary elimination management; Patient reports getting wet or soiling self or incontinence	Impaired Urinary Elimination (00016)
		Functional Urinary Incontinence (00020)
		Overflow Urinary Incontinence (00176)
		Reflex Urinary Incontinence (00018)
		Stress Urinary Incontinence (00017)
		Urge Urinary Incontinence (00019)
Sleeping Medications	Sedatives; CNS agents; Hypnotics	NA

SNOMED CT. The SNOMED CT terminology was searched utilizing the NCI term browser and the filters described in the methods section. Several key words resulted in a number of potential matches, while others returned no matches (see Appendix B for returns for each key word). The key words 'weak gait' returned no matches but the key word 'ataxia' returned potential 72 matches due to the of the variety of different types of ataxia. Only the term 'ataxia' was selected as the most appropriate lexical match. The key word dementia returned 92 matches and delirium returned 28. Only the exact lexical matches of each were mapped. The key word confusion returned 35 potential matches. Only acute and chronic confusion were mapped. The term 'MMSE' returned one potential match, 'Mini-mental state examination.' However, this concept represents the application of the scale itself, not the results of the examination, so it was not included in the mapping. The key words 'urinary incontinence' returned 24 potential matches, several of which were procedures for the treatment of urinary incontinence; therefore, only the lexical match 'urinary incontinence' selected. The key words, 'sleeping medications' returned no matches but there were 54 potential matches for the key word 'sedatives' and 37 for the terms 'hypnotics.' However, many of the returned matches represented disorders, such as 'poisoning by mixed sedative' and thus were not selected. Table 15 displays the representational terms from the evidence mapped to SNOMED CT terms.

Table 15

Risk for Falls and Fall Risk Factors Mapped to SNOMED CT

General Term	Representational Terms from Evidence	SNOMED CT Concepts (Code)
Risk for Falls	Potential for falls; Low, medium, high risk for falls; Morse score 45 or greater; STRATIFY score 2 or greater	At Risk for Falls (129839007) At Low Risk for Falls (439430008)
History of Falls	Presenting with a fall; History of fall in past 3 months and/or this admission; Fall in past 2 months	History of fall (428942009)
Impaired Gait	Weak gait pattern; Gait abnormality; Ataxia	Ataxia (20262006) Abnormal gait (22325002)

Table 15

Risk for Falls and Fall Risk Factors Mapped to SNOMED CT

General Term	Representational Terms from Evidence	SNOMED CT Concepts (Code)
Cognitive Impairment	Impaired mental status; Dementia; Delirium; MMSE score; Senility organic mental disorders; Confusion; Confused patient; Impaired judgment/ lack of safety awareness; Changes in mental status; Disorientation (memory loss)	Altered mental status (419284004) Transient altered mental status (433082007) Dementia (52448006) Delirium (2776000) Disorientated (62476001) Acute confusion (130987000) Chronic confusion (130988005) Impaired judgement (38504003) Senility (271873000) Senility (32864002) Organic mental disorder (1149008)

Table 15

Risk for Falls and Fall Risk Factors Mapped to SNOMED CT

General Term	Representational Terms from Evidence	SNOMED CT Concepts (Code)
Urinary Incontinence	Urinary incontinence; Urinary incontinence management; Urinary elimination management; Patient reports getting wet or soiling self or incontinence	Urinary incontinence (165232002) Incontinence (48340000)
Sleeping Medications	Sedatives; CNS agents; Hypnotics	Sedative (349859000) Sedative (372614000) Hypnotic agent (372585002) Hypnotic AND/OR sedative (439304005) Anxiolytic, sedative AND/OR hypnotic (105917007)

Aurora "Risk for Falls." First, the key words were used to potential matches to the 30 data element names. Nineteen of the 30 data elements were identified as potential lexical matches or those that may contain permissible values that would provide potential lexical matches. Each of the 19 data elements were reviewed. Data elements that included the permissible values, 'WDL' and 'WDL Except' were not mapped because the level of detail about the 'exception' was not included in these elements. Seven data elements were found to contain lexical matches to either the data element name or one or more of the permissible values for that data element. For those data elements with matching permissible values, only the permissible values that were lexical matches were mapped. For example, the permissible values for the data element, 'Changes in Voiding Habits Details' included frequency, incontinence, nocturia, polyuria and urgency, but only incontinence matched the key words.

History of falls mapped to the data element labeled, 'musculoskeletal health history data element', and the permissible value, 'History of fall within 1 year.' The key words, ataxia, weak gait pattern and gait abnormality produced no lexical matches. The data element, 'Gait-MS Assessment,' was reviewed and while the permissible values did include terms such as staggering and limping, which could semantically be mapped to the key words, the design of this research is limited to lexical matching. Table 16 displays the selected terms mapped from the Aurora "Risk for Falls" group.

Table 16

Risk for Falls and Fall Risk Factors Mapped to Aurora "Risk for Falls"

Risk	Representational Terms from Evidence	USHIK Name (Constraint ID)	Permissible Values
Risk for Falls	Potential for falls; Low, medium, high risk for falls; Morse score 45 or greater; STRATIFY score 2 or greater	NA	NA
History of Falls	Presenting with a fall; History of fall in past 3 months and/or this admission; Fall in past 2 months	Musculoskeletal-Health History (UWMilwaukee.111189v.1)	History of fall within last year
Impaired Gait	Weak gait pattern; Gait abnormality; Ataxia	NA	NA
Dementia	Impaired mental status; Dementia; Delirium; MMSE score; Senility organic mental disorders; Confusion; Confused patient; Impaired judgment/ lack of safety awareness; Changes in mental status; Disorientation	Neurological-Health History (UWMilwaukee111191v.1)	

Table 16

Risk for Falls and Fall Risk Factors Mapped to Aurora "Risk for Falls"

Risk	Representational Terms from Evidence	USHIK Name (Constraint ID)	Permissible Values
	(memory loss)	Orientation-Neuro Assessment (UWMilwaukee.111196v.1)	Disoriented to person; Disoriented to place; Disoriented to time
Urinary Incontinence	Urinary incontinence; Urinary incontinence management; Urinary elimination management; Patient reports getting wet or soiling self or incontinence	Changes in Voiding Habits Details (UWMilwaukee.111198v.1)	Incontinence
Sleeping Medications	Sedatives; CNS agents; Hypnotics	NA	NA

ICD-9 CM. The key words and their lexical variants were used to search the ICD-9 CM terminology thorough the NCI Term Browser. Unlike the search of the SNOMED CT terminology, the search of the ICD-9 CM terminology resulted in fewer returned terms per key words (see Appendix B for summary of the number of returned matches per key word). As with the SNOMED CT mapping, when a key word search returned multiple terms and more than one included the key words, only the closest lexical matches were selected. For example, the term 'confusion' returned seven potential matches, but the only appropriate lexical matches were already mapped from the key word delirium. There were four potential matches returned with the key word 'gait,' but three represented procedures or interventions, therefore, 'abnormality of gait' was mapped. The key word 'ataxia' returned ten potential matches and none were lexical matches. Neither the key words, 'impaired judgment' or 'lack of safety awareness' returned any potential matches but the key words 'mental status' returned three potential matches, one of which was appropriate to map. The search with the key word 'disorientation' returned two potential matches, neither of which was an appropriate lexical map. Finally, the terms that represented sleeping medications were used as key word searches, but only returned matches related to 'poisoning' with medications or 'adverse events,' so none were included. Table 17 displays the final mapping of the representational terms to ICD-9 CM diagnoses.

Table 17

Risk for Falls and Fall Risk Factors Mapped to ICD-9 CM

Risk	Representational Terms from Evidence	ICD-9 CM (Code)
Risk for Falls	Potential for falls; Low, medium, high risk for falls; Morse score 45 or greater; STRATIFY score 2 or greater	NA
History of Falls	Presenting with a fall; History of fall in past 3 months and/or this admission; Fall in past 2 months	History of Fall (V15.88)
Impaired Gait	Weak gait pattern; Gait abnormality; Ataxia	Abnormality of gait (781.2)

Table 17

Risk for Falls and Fall Risk Factors Mapped to ICD-9 CM

Risk	Representational Terms from Evidence	ICD-9 CM (Code)
Cognitive Impairment	Impaired mental status; Dementia; Delirium; MMSE score; Senility organic mental disorders; Confusion; Confused patient; Impaired judgment/ lack of safety awareness; Changes in mental status; Disorientation (memory loss)	Senile dementia (290.0)
		Dementia, unspecified without behavioral disturbance (294.20)
		Delirium due to conditions classified elsewhere (293.0)
		Senility without mention of psychosis (797)
		Altered mental status (780.97)
		Reactive Confusion (298.2)
		Memory Loss (780.93)
		Other Specified Transient Organic Mental Disorders (293.89)

Table 17

Risk for Falls and Fall Risk Factors Mapped to ICD-9 CM

Risk	Representational Terms from Evidence	ICD-9 CM (Code)
Urinary Incontinence	Urinary incontinence; Urinary incontinence management; Urinary elimination management; Patient reports getting wet or soiling self or incontinence	Urinary incontinence (788.3)
		Functional urinary incontinence (788.91)
		Other urinary incontinence (788.39)
		Urinary incontinence, unspecified (788.3)
Sleeping Medications	Sedatives; CNS agents; Hypnotics	NA

AHFS. The American Formulary Service (AFHS) Pharmacological Therapeutic Classification system was used to map drug classes that were found to be significantly associated with falls in acute care. Table 18 displays the mapped AHFS class number and description. The AHFS class 28:00 is a first level hierarchy in the classification system and includes eleven, more granular, second level hierarchal classes, while class 28:24:92 represents a third level hierarchal class without subordinate classes of drugs. Consequently, if a patient's clinical record contains a class 28:24:92 drug, it will also contain a class 28:00 drug.

Table 18

Risk for Falls and Fall Risk Factors Mapped to AHFS

Risks	Representational Terms from Evidence	AHFS Class Description (Code)
Sleeping Medications	Sedatives; Hypnotics; CNS agents	Central Nervous System agents (28:00) Anxiolytics, sedatives, and hypnotics; miscellaneous (28:24:92)

Research Question Two: How are the selected fall risk factors and problem, 'risk for falls' represented in a clinical information system?

Locating terms. Once the terms for the selected fall risk factors and the problem, 'risk for falls' were mapped to the five standardized terminologies, the researcher worked with staff from the study site to identify the location of the standardized terms within the clinical information system. The clinical content coordinator, who was knowledgeable about the content build for the inpatient clinical information system, was consulted to help locate where within the clinical information system the terms were visible to clinicians. Each clinical role has access to different sections within the electronic clinical record and varying access to specific flow sheets. In the simulated environment, the researcher and the coordinator were able to access a variety of sections of the electronic medical record using sign in codes that simulated the access given to prescribers, registered nurses, and physical medicine and rehab therapists. Side by side, the researcher and the clinical content coordinator searched the simulated clinical information system for mapped terms that represented the problem, 'risk for falls,' and each of the five selected fall risk factors. In addition to searching for the terms mapped from the standardized terminologies, the representational terms identified in the evidence were used as key words to search for matches in the clinical information system that were not necessarily represented in a standardized terminology. The terms representing the five fall risk factors were located in discrete fields in the following sections of the electronic record: (1)

nursing flow sheets; (2) rehabilitation flow sheets; (3) the medical history; (4) the problem list; (5) the care plan and (6) the orders.

Standardized terms. The standardized terms mapped from SNOMED CT and ICD-9 CM were located in the both the '*Medical History'* and the '*Problem List'* sections of the clinical information system. In both sections, the researcher was able to enter the mapped terms into a search field and SNOMED CT and ICD-9 CM terms were returned. While all of the mapped ICD-9 CM terms were located with the search, not all of the mapped SNOMED CT terms were returned. The data elements and corresponding permissible values mapped form the Aurora "Risk for Falls' constraint group did not exist as coded USHIK data elements in the study site's clinical information system. However, some of the permissible values from the group, such as 'disoriented to place,' matched site-specific terms located in the flow sheets. While no NANDA-I diagnoses were located, the study site's '*Care Plan'* section did contain a vendor specific list of similar nursing diagnoses (e.g. Fall/Trauma/Injury Risk). In the '*Orders*' section of the clinical information system, the clinician had the ability sort the medication by drug class. One of the drug classes was labeled, 'Sedatives/Hypnotics' which did not match the AHFS terminology.

Non-standardized terms. The representational terms identified in the evidence were utilized as key words to search for matches in the clinical information system that were not necessarily represented using standardized terminology. The clinical content coordinator and the researcher used the key

words to search the '*Nursing Flow Sheets,'* the '*Rehabilitation Flow Sheets*,' and the '*Care Plan'* sections of the clinical information system, as the clinical content coordinator was familiar with the content contained in these sections. In addition to the clinical content coordinator, the study site's clinical information systems pharmacy analyst was consulted to assist in identifying how the medications were classified in the '*Orders*' section of the clinical information system. Upon investigation, the clinical information systems pharmacy analyst discovered that the medication orders in this clinical information system were built to sort by a vendor specific classification system. Therefore, the key words were mapped to the vendor specific classifications terms and not to the AHFS Pharmacological Therapeutic Classification system.

Locating machine-readable codes. After each standardized and non-standardized term was located within the clinical information system, the researcher worked with another clinical information analyst and the data warehouse analyst to identify the machine-readable codes for each of the terms mapped from the study site's clinical information system. The clinical information analyst located the machine-readable codes for the '*Care Plan*,' '*Rehabilitation Flow Sheets'* and '*Nursing Flow Sheets'*.' The data warehouse analyst was consulted to identify the machine-readable codes for the SNOMED CT and ICD-9 CM terms in the '*Medical History'* and the '*Problem List'* sections of the system. While the ICD-9 CM machine-readable codes (i.e. the ICD-9 CM codes themselves), were located in both the '*Medical History'* and the '*Problem List'* sections of the clinical information system, only those recorded in the '*Problem*

List' section were retrievable from the electronic data warehouse. The SNOMED CT terms, which were visible in both the '*Medical History'* and the '*Problem List'* sections of the clinical information system had no associated machine-readable codes retrievable in the electronic data warehouse.

Final mapping. The following section displays the results of the terminology mapping to the study sites clinical information system. The first five columns of each table include the standard terms mapped from the five selected terminologies. Each terminology is displayed in a different column deliberately, so as to avoid the suggesting that the terms are mapped to each other across terminologies. The sixth column represents non-standardized terms that matched the representational terms from the evidence, the seventh column indicates the location of terms in the clinical information system, and the machine-readable code associated with the term.

Risk for falls. While the SNOMED CT concept, "At Risk for Falls" was located in clinical information system, the concept 'At Low Risk for Fall," was not visible. As stated in the previous section, SNOMED CT codes were not retrievable from the electronic data warehouse and therefore, no associated machine-readable code is included on the mapping. Risk for falls was also found to be represented in the clinical information system in the '*Care Plan'* and '*Nursing Flow Sheet'* sections. Table 19 displays the results of the terminology mapping of the problem, 'risk for falls' to the study site's clinical information system.

Table 19

Risk for falls Mapping to the Clinical Information System

NANDA-I (Codes)	SNOMED CT (Code)	ICD-9	Aurora Risk For Falls (USHIK Code) [Permissible Values]	AHFS	Study Site Clinical Information System (Permissible Values)	Location in the Clinical Information System (Electronic Data Warehouse Machine Readable Code)
Risk for falls (00155)						Does Not Exist
	At Risk for Falls (129839007)					Medical History & Problem List (None)
	At Low Risk for Fall (439430008)					Does Not Exist
		NA	NA	NA		NA
					Morse Total Score (0-110)	Patient Care Summary Flow Sheet (FLO 3051110)
					Falls/Trauma/Injury Risk CPG	Care Plan (LCE 660265)

History of falls. As with 'risk for falls,' the ICD-9 CM codes and SNOMED CT terms were located in the '*Medical History'* and '*Problem List'* sections of the system and existed side by side in the search field. Two additional, non-standardized terms were located within the clinical information system. Both 'History of Falling' and 'Fall History' existed as rows in the "*Nursing Flow Sheets'* section. The "History of Falling" data element was displayed on the screen grouped with the other items from the Morse Falls Scale. Each Morse Scale item was displayed as its own row, with its own permissible values for the clinician to select. The clinician had the ability to select the permissible value of either 'Yes=25' or 'No=0' for the data element 'History of Falling,' but the system did not allow both options to be selected. For the data element, 'Fall History," the permissible values included, 'Frequent falls,' 'Fall during current hospitalization,' and 'Admit due to a fall.' Unlike the Morse Fall Scale item, 'History of Falling,' clinicians could select any or all of the permissible values for the 'Fall History' data element. Table 20 displays the mapping of the selected standardized terms for 'history of falls' to the study site's clinical information system.

Table 20

History of Falls Mapping to the Clinical Information System

NANDA-I (Codes)	SNOMED CT (Code)	ICD-9	Aurora Risk for Falls (USHIK Code) [Permissible Value]	AHFS	Study Site Clinical Information System (Permissible Values)	Location in the Clinical Information System (Electronic Data Warehouse Machine Readable Code)
NA						NA
	History of fall (428942009)					Medical History/Problem List (None)
		History of Fall (V15.88)				Medical History/Problem List (V15.88)
			Musculoskeletal-Health History (UWMilwaukee.111189v.1) [History of fall within last year]			Does not Exist
				NA		NA
					History of Falling (Yes=25; No=0)	Patient Care Summary Flow sheet (FLO 305030)

Table 20

History of Falls Mapping to the Clinical Information System

NANDA-I (Codes)	SNOMED CT (Code)	ICD-9	Aurora Risk for Falls (USHIK Code) [Permissible Value]	AHFS	Study Site Clinical Information System (Permissible Values)	Location in the Clinical Information System (Electronic Data Warehouse Machine Readable Code)
					Fall History (Frequent falls; Fall during current hospitalization; Admit due to a fall)	Patient Care Summary Flow sheet (FLO 3044001132)

Impaired gait. As with 'history of falls,' the ICD-9 codes and SNOMED CT terms were located in the '*Medical History'* and '*Problem List'* sections of the system and existed side by side in the search field. Two additional, non-standardized terms were located within the clinical information system. One data element representing impaired gait was located in the '*Rehabilitation Flow Sheets'* section. The flow sheet was located when the researcher and the clinical content coordinator were signed into the clinical information system as a physical therapist. This physical therapists flow sheet was not immediately visible when the researcher signed into the clinical information system as a nurse, but could be located through a search. The physical therapist flow sheet row on labeled, 'Gait Analysis Deviation' had several permissible values to select, one of which was a lexical match to the key word 'ataxia.' One additional matching flow sheet data element was located in the '*Nursing Flow Sheet'* section of the system. 'Gait/Transferring' existed as a row grouped with the other Morse Fall Scale items. The permissible values for the 'Gait/Transferring' nursing data element included the terms 'weak' and 'impaired.' Like the 'history of falling," data element, the clinical information system only allowed one permissible value to be selected. Table 21 displays the terminology mapping of the fall risk factor, impaired gait, to the study site's clinical information system.

Table 21

Impaired Gait Mapping to Clinical Information System

NANDA-I (Codes)	SNOMED CT (code)	ICD-9	Aurora Risk for Falls (USHIK Code) [Permissible Value]	AHFS	Study Site Clinical Information System (Permissible Values)	Location in the Clinical Information System (Electronic Data Warehouse Machine Readable Code)
Impaired Physical Mobility (00085)						Does not Exist
	Ataxia (20262006)					Medical History/Problem List (None)
	Abnormal gait (22325002)					Medical History/Problem List (None)
		Abnormality of gait (781.2)				Medical History/Problem List (781.2)
			NA	NA		NA
					Gait Analysis Deviation (ataxic gait)	Adult Daily Rehab Note (FLO 665060)

Table 21

Impaired Gait Mapping to Clinical Information System

NANDA-I (Codes)	SNOMED CT (code)	ICD-9	Aurora Risk for Falls (USHIK Code) [Permissible Value]	AHFS	Study Site Clinical Information System (Permissible Values)	Location in the Clinical Information System (Electronic Data Warehouse Machine Readable Code)
					GAIT/ TRANSFERRING (Weak=10; Impaired=20)	Patient Care Summary Flow sheet (FLO 305080)

Cognitive impairment. As with 'history of falls,' the ICD-9 codes and SNOMED CT terms were located in the '*Medical History'* and '*Problem List'* sections of the system and existed side by side in the search field. Two of the SNOMED CT codes, 'Transient alerted mental status' and 'Impaired Judgment' were not located in either the '*Medical History'* or '*Problem List'* sections. The previously discussed SNOMED CT terms were located along side an ICD-9 CM term, so perhaps SNOMED CT terms were only visible if there was an associated ICD-9 CM term. The two data elements from the Aurora "Risk for Falls" group, did not exist in the study site's system, however, the permissible values related to 'disorientation' did match permissible values that were visible in the '*Nursing Flow Sheet'* section. Nine additional site-specific, terms matched one or more of the key words. Table 22 displays the terminology mapping of the fall risk factor, cognitive impairment, to the study site's clinical information system.

Table 22

Cognitive Impairment Mapping to Clinical Information System

NANDA-I (Codes)	SNOMED CT (code)	ICD-9	Aurora Risk for Falls (USHIK Code) [Permissible Value]	AHFS	Study Site Clinical Information System (Permissible Values)	Location in the Clinical Information System (Electronic Data Warehouse Machine Readable Code)
Acute Confusion (00128)						Does not Exist
Chronic Confusion (00129)						Does not Exist
Impaired Memory (00131)						Does not Exist
	Altered mental status (419284004)					Medical History/Problem List (None)

Table 22

Cognitive Impairment Mapping to Clinical Information System

NANDA-I (Codes)	SNOMED CT (code)	ICD-9	Aurora Risk for Falls (USHIK Code) [Permissible Value]	AHFS	Study Site Clinical Information System (Permissible Values)	Location in the Clinical Information System (Electronic Data Warehouse Machine Readable Code)
	Transient altered mental status (433082007)					Does not Exist
	Dementia (52448006)					Medical History/Problem List (None)
	Delirium (2776000)					Medical History/Problem List (None)
	Disoriented (62476001)					Medical History/Problem List (None)
	Acute confusion (130987000)					Medical History/Problem List (None)

Table 22

Cognitive Impairment Mapping to Clinical Information System

NANDA-I (Codes)	SNOMED CT (code)	ICD-9	Aurora Risk for Falls (USHIK Code) [Permissible Value]	AHFS	Study Site Clinical Information System (Permissible Values)	Location in the Clinical Information System (Electronic Data Warehouse Machine Readable Code)
	Chronic confusion (130988005)					Medical History/Problem List (None)
	Impaired judgment (38504003)					Does not Exist
	Senility (271873000) Or (32864002)					Medical History/Problem List (None)
	Organic mental disorder (1149008)					Medical History/Problem List (None)

Table 22

Cognitive Impairment Mapping to Clinical Information System

NANDA-I (Codes)	SNOMED CT (code)	ICD-9	Aurora Risk for Falls (USHIK Code) [Permissible Value]	AHFS	Study Site Clinical Information System (Permissible Values)	Location in the Clinical Information System (Electronic Data Warehouse Machine Readable Code)
	O/E mentally confused (162702000)					Does not Exist
	Transient memory loss (307413004)					Medical History/Problem List (None)
		Senile dementia (290.0)				Medical History/Problem List (290.0)
		Dementia, unspecified without behavioral disturbance (294.20)				Medical History/Problem List (274.20)

Table 22

Cognitive Impairment Mapping to Clinical Information System

NANDA-I (Codes)	SNOMED CT (code)	ICD-9	Aurora Risk for Falls (USHIK Code) [Permissible Value]	AHFS	Study Site Clinical Information System (Permissible Values)	Location in the Clinical Information System (Electronic Data Warehouse Machine Readable Code)
		Delirium due to conditions classified elsewhere (293.0)				Medical History/Problem List (293.0)
		Senility without mention of psychosis (797)				Medical History/Problem List (797)
		Altered mental status (780.97)				Medical History/Problem List (780.97)
		Memory loss (780.93)				Medical History/Problem List (780.93)

Table 22

Cognitive Impairment Mapping to Clinical Information System

NANDA-I (Codes)	SNOMED CT (code)	ICD-9	Aurora Risk for Falls (USHIK Code) [Permissible Value]	AHFS	Study Site Clinical Information System (Permissible Values)	Location in the Clinical Information System (Electronic Data Warehouse Machine Readable Code)
		Other specified organic mental disorders (293.89)				Medical History/Problem List (293.89)
		Reactive confusion (298.2)				Medical History/Problem List (298.2)
			Neurological-Health History (UWMilwaukee111191v.1) [Dementia]			Does not Exist

Table 22

Cognitive Impairment Mapping to Clinical Information System

NANDA-I (Codes)	SNOMED CT (code)	ICD-9	Aurora Risk for Falls (USHIK Code) [Permissible Value]	AHFS	Study Site Clinical Information System (Permissible Values)	Location in the Clinical Information System (Electronic Data Warehouse Machine Readable Code)
			Orientation-Neuro Assessment (UWMilwaukee.111196v.1) [Disoriented to person, disoriented to time, disoriented to place]			Does not Exist
				NA		NA
					Other Conditions Related to Falls (Acute confusion; Chronic confusion)	Patient Care Summary Flow sheet
					Orientation (Disoriented to person; Disoriented to place; Disoriented to time; Disoriented X 4)	Patient Care Summary Flow sheet

Table 22

Cognitive Impairment Mapping to Clinical Information System

NANDA-I (Codes)	SNOMED CT (code)	ICD-9	Aurora Risk for Falls (USHIK Code) [Permissible Value]	AHFS	Study Site Clinical Information System (Permissible Values)	Location in the Clinical Information System (Electronic Data Warehouse Machine Readable Code)
					Memory Deficit (Short term memory loss; Long term memory loss; Forgetful; New learning, recall loss)	Patient Care Summary Flow sheet
					Orientation (Disoriented to any of the following-person, place, time, situation, x4)	Admission Physical Therapy Evaluation Flow sheet
					Short Term Memory (Impaired)	Admission Physical Therapy Evaluation Flow sheet
					Long Term Memory (Impaired)	Admission Physical Therapy Evaluation Flow sheet

Table 22

Cognitive Impairment Mapping to Clinical Information System

NANDA-I (Codes)	SNOMED CT (code)	ICD-9	Aurora Risk for Falls (USHIK Code) [Permissible Value]	AHFS	Study Site Clinical Information System (Permissible Values)	Location in the Clinical Information System (Electronic Data Warehouse Machine Readable Code)
					Mini Mental Exam (0-30)	Admission Physical Therapy Evaluation Flow sheet
					Personal Safety and Judgment (Impaired; At risk behaviors)	Admission Physical Therapy Evaluation Flow sheet
					Confusion, Acute/Chronic CPG	Care Plan (LCE 660052)

*Urinary incontinence***.** As with other fall risk factors, the ICD-9 codes and SNOMED CT terms were located in the '*Medical History'* and '*Problem List'* sections of the system and existed side by side in the search field. The data element, 'Change in voiding habits,' from the Aurora "Risk for Falls" group, did not exist in the study site's system, however, the permissible value, 'incontinence', did match a permissible value that existed in two different rows in the '*Nursing Flow Sheet'* section. Table 23 displays the mapping of the standardized terms representing urinary incontinence to the study site's clinical information system.

Table23

Urinary Incontinence Mapping to Clinical Information System

NANDA-I (Codes)	SNOMED CT (code)	ICD-9	Aurora Risk For Falls (USHIK Code) [Permissible Values]	AHFS	Study Site Clinical Information System (Permissible Values)	Location in the Clinical Information System (Electronic Data Warehouse Machine Readable Code)
Impaired Urinary Elimination (00016)						Does Not Exist
Functional Urinary Incontinence (00020)						Does Not Exist
Overflow Urinary Incontinence (00176)						Does Not Exist
Reflex Urinary Incontinence (00018)						Does Not Exist
Impaired Urinary Elimination (00016)						Does Not Exist

Table23

Urinary Incontinence Mapping to Clinical Information System

NANDA-I (Codes)	SNOMED CT (code)	ICD-9	Aurora Risk For Falls (USHIK Code) [Permissible Values]	AHFS	Study Site Clinical Information System (Permissible Values)	Location in the Clinical Information System (Electronic Data Warehouse Machine Readable Code)
Stress Urinary Incontinence (00017)						Does Not Exist
Urge Urinary Incontinence (00019)						Does Not Exist
	Urinary incontinence (165232002)					Medical History/Problem List
	Incontinence (48340000)					Medical History/Problem List (None)
		Urinary incontinence (788.3)				Medical History/Problem List (788.3)

Table23

Urinary Incontinence Mapping to Clinical Information System

NANDA-I (Codes)	SNOMED CT (code)	ICD-9	Aurora Risk For Falls (USHIK Code) [Permissible Values]	AHFS	Study Site Clinical Information System (Permissible Values)	Location in the Clinical Information System (Electronic Data Warehouse Machine Readable Code)
			Changes in Voiding Habits Details (UWMilwaukee.111198v.1) [Incontinence]			Does Not Exist
				NA		NA
					Elimination Risk Factors Related to Falls (incontinence)	Patient Care Summary Flow sheet
					Voiding Characteristics (incontinence)	Patient Care Summary Flow sheet
					Urine Elimination, Impaired	Care Plan (LCE 660086)

Sleeping medications. The mapped SNOMED CT terms were not visible to the clinician in either the *'Medical History'* or the '*Problem List'* sections of the clinical information system. The mapped AHFS terms, drug classifications, did not display as part of the '*Orders*' section of the system. Consultation with the pharmacy informatics analyst revealed that medications could be sorted by class in the '*Orders*' section, but the classification scheme was vendor specific. Table 24 displays the mapping of the standardized terms representing sleeping medications to the study site's clinical information system.

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Table 24

Sedatives and Hypnotics Mapped to the Clinical Information System

NANDA-I (Codes)	SNOMED CT (code)	ICD-9	Aurora Risk For Falls (USHIK Code) [Permissible Values]	AHFS	Study Site Clinical Information System (Permissible Values)	Location in the Clinical Information System (Electronic Data Warehouse Machine Readable Code)
NA						NA
	Sedative (349859000)					Does Not Exist
	Sedative (372614000)					Does Not Exist
	Hypnotic agent (372585002)					Does Not Exist
	Hypnotic AND/OR sedative (439304005)					Does Not Exist

Table 24

Sedatives and Hypnotics Mapped to the Clinical Information System

NANDA-I (Codes)	SNOMED CT (code)	ICD-9	Aurora Risk For Falls (USHIK Code) [Permissible Values]	AHFS	Study Site Clinical Information System (Permissible Values)	Location in the Clinical Information System (Electronic Data Warehouse Machine Readable Code)
	Anxiolytic, sedative AND/OR hypnotic (105917007)					Does Not Exist
		NA	NA			NA
				Central Nervous System agents (28:00)		Does Not Exist
				Anxiolytics, sedatives, and hypnotics; miscellaneous (28:24:92)		Does Not Exist

Table 24

Sedatives and Hypnotics Mapped to the Clinical Information System

NANDA-I (Codes)	SNOMED CT (code)	ICD-9	Aurora Risk For Falls (USHIK Code) [Permissible Values]	AHFS	Study Site Clinical Information System (Permissible Values)	Location in the Clinical Information System (Electronic Data Warehouse Machine Readable Code)
					Medications Related to Falls (Hypnotics/sedatives)	Patient Care Summary Flow sheet
					Sedatives/Hypnotics	Orders Section
					CNS Agents	Orders Section

Research Question Three: Which of the selected fall risk factors and problem, 'risk for falls' can be retrieved from the electronic health record?

After the standardized terms were mapped to the clinical information system and additional site-specific terms were identified, a list of the electronic data warehouse machine-readable codes was created. As discussed in the previous section, among the standardized terminologies, only the ICD-9 CM and SNOMED CT terms were located in the study site's clinical information system. Only the ICD-9 CM terms that were located in the '*Problem List'* section of the clinical information system were available for retrieval from the electronic data warehouse. The vendor specific medication classification 'Sedatives/Hypnotics' and 'CNS Agents' that were found to represent the fall risk factor 'sleeping medications' in the '*Orders*' section, were retrievable through medication charging data in the data warehouse; therefore, the data requested from the electronic data warehouse represented sleeping medications administered. Among the remaining site-specific terms, those that mapped from the '*Nursing Flow Sheet'* and the '*Rehabilitation Flow Sheet'* sections of the clinical information system were retrievable in the electronic data warehouse, but terms mapped from the '*Care Plan'* section were not retrievable.

Results. Data recorded in 995 unique hospital episodes were retrieved. Tables' 25-29 display the frequencies with which each of the standard and non-standard terms were retrieved from the electronic data warehouse. In addition to the prevalence, each table displays where the mapped terms were located in the

clinical information system, including the flow sheet row name if appropriate, and the how the terms were retrieved from the electronic data warehouse.

Risk for falls. The only data element to represent 'risk for falls' that could be extracted from the data warehouse was the total Morse Fall Scale score, which was recorded in the '*Nursing Flow Sheet'* section of the electronic record. The data warehouse analyst was able extract the number of patients who had a score of 45 or greater at any time during the episode of care (see Table 25).

Table 25

Prevalence of 'Risk For Falls'

Location in the Clinical Information System (Flow Sheet Row Name)	**Retrieved from the Electronic Data Warehouse**	**Percentage**
Nursing Flow Sheet (Morse Fall Scale)	Score of 45 or Greater	64.7%

History of falls. History of falls was represented by the ICD-9 CM code V15.88 and two terms located in the *'Nursing Flow Sheet'* section. 'History of falls' was found to be documented infrequently in the '*Problem List'* section but more frequently in the '*Nursing Flow Sheet'* section. Table 26 displays the percent of records with documentation of 'history of falls.'

Table 26

Prevalence of History of Falls

Location in the Clinical Information System (Flow Sheet Row Name)	**Retrieved from the Electronic Data Warehouse**	**Percentage**
Problem List	History of falls (V15.88)	1.4%
Nursing Flow Sheet (History of Falling)	Yes=25	33.8%
Nursing Flow Sheet (Fall History)	Frequent falls; **OR** Fall during current hospitalization; **OR** Admit due to a fall	26.1%

Impaired gait. Impaired gait was represented by the ICD-9 CM code 781.2, one term located in the *'Nursing Flow Sheet'* and one term located in the *'Rehabilitation Flow Sheet'* section. The term 'ataxic gait' in the '*Rehabilitation Flow Sheet'* section was not entered on any patient's record. Either 'weak' or 'impaired' was documented in the '*Nursing Flow Sheet'* section among 59% of the records. Table 27 displays the percent of patient records with documentation of terms that represented impaired gait.

Table 27

Prevalence of Impaired Gait

Location in the Clinical Information System (Flow Sheet Row Name)	**Retrieved from the Electronic Data Warehouse**	**Percentage**
Problem List	Abnormality of Gait (781.2)	3.2%
Rehabilitation Flow Sheet (Gait Analysis Deviation)	Ataxic gait	None Entered
Nursing Flow Sheet (Gait/ Transferring)	Weak **OR** Impaired	*59.3%*

Cognitive impairment. The frequency with which ICD-9 CM codes representing cognitive impairment were recorded in the '*Problem List'* section was minimal. The documentation of terms representing 'cognitive impairment' recorded in the '*Nursing Flow Sheet'* section were more frequently noted than those represented by ICD-9 CM codes or in the '*Rehabilitation Flow Sheet'* section, but there was no documentation of 'memory deficit' in the '*Nursing Flow Sheet'* section. Table 28 displays the percent of patient records with documentation of terms that represented cognitive impairment.

Table 28

Prevalence of Cognitive Impairment

Location in the Clinical Information System (Flow Sheet Row Name)	**Retrieved from the Electronic Data Warehouse**	**Percentage**
Problem List	Senile dementia (290.0)	0.1%
Problem List	Dementia, unspecified without behavioral disturbance (294.20)	1.8%
Problem List	Delirium due to conditions classified elsewhere (293.0)	0.8%
Problem List	Senility without mention of psychosis (797)	0%
Problem List	Alerted mental status (780.97)	1.0%
Problem List	Other specified transient organic mental disorders (293.89)	0%
Problem List	Reactive confusion (298.2)	0%
Problem List	Memory Loss (780.93)	2.4%
Nursing Flow Sheet (Other Conditions Related to Falls)	Acute confusion **OR** Chronic confusion	17.5%
Nursing Flow Sheet (Orientation)	Disoriented to person; **OR** Disoriented to place; **OR** Disoriented to time; **OR** Disoriented X 4	22.8%

Table 28

Prevalence of Cognitive Impairment

Location in the Clinical Information System (Flow Sheet Row Name)	**Retrieved from the Electronic Data Warehouse**	**Percentage**
Nursing Flow Sheet (Memory Deficit)	Short term memory loss; **OR** Long term memory loss; **OR** Forgetful; **OR** New learning, recall loss	None Entered
Rehabilitation Flow Sheet (Orientation)	Disoriented to: person; **OR** place; **OR** time; **OR** situation' **OR** x4 (or any combination)	None Entered
Rehabilitation Flow Sheet (Short Term Memory)	Impaired	None Entered
Rehabilitation Flow Sheet (Long Term Memory)	Impaired	None Entered
Rehabilitation Flow Sheet (Mini Mental Exam)	0-30	None Entered
Rehabilitation Flow Sheet (Personal Safety and Judgment)	Impaired **OR** At risk behaviors	None Entered

Urinary Incontinence. The two ICD-9 CM codes representing urinary incontinence were recorded in few of the records. In contrast, urinary incontinence was documented in 17.6% of the records in the flow sheet row named 'elimination risk factors to falls' and 16.5% in the flow sheet row named 'voiding characteristics.' Table 29 displays the percent of patient records with documentation of terms that represent urinary incontinence.

Table 29

Prevalence of Urinary Incontinence

Location in the Clinical Information System	**Retrieved from the Electronic Data Warehouse**	**Percentage**

(Flow Sheet Row Name)		
Problem List	Urinary incontinence (788.3)	3.1%
Problem List	Other urinary incontinence (788.39)	0.1%
Nursing Flow Sheet (Elimination Risk Factors Related to Falls)	Incontinence	17.6%
Nursing Flow Sheet (Voiding Characteristics)	Incontinence	16.5%

Sleeping Medications. The term, 'hypnotics/sedatives' was located in the flow sheet row named 'medications related to falls' in the '*Nursing Flow Sheet'* sections. While the patient's medication orders could be sorted by therapeutic class in the '*Orders*' section of the clinical information system, medications sorted by therapeutic class had to be retrieved as charges for medications administered. The prevalence of nursing documentation of sleeping medications ordered and sleeping medications charged for were similar.

Table 30

Prevalence of Sleeping Medications

Location in the Clinical Information System (Flow Sheet Row Name)	Retrieved from the Electronic Data Warehouse	Percentage
Nursing Flow Sheet (Medications Related to Falls)	Hypnotics/Sedatives	16.7%
Orders Section	Sedatives/Hypnotics Charges	18.1%
Orders Section	CNS Agents Charges	17.5%

Summary

Representation of the problem, 'risk for falls,' and fall risk factors in patients' clinical records varies across falls risk research. The representational

terms found in the literature were used as 'key words' to complete a mapping to terms within five diverse, standardized terminologies (NANDA-I, SNOMED CT, ICD-9 CM, Aurora "Risk for Falls" Constraint Group, and AHFS). Lexical terminology mapping provided standardized terms for the problem, 'risk for falls,' and the five selected fall risk factors. In this research, SNOMED CT terms mapped to each of the five fall risk factors and the problem, 'risk for falls, and NANDA-I diagnoses could be mapped to all but two of the five fall risk factors. ICD-9 CM terms could be mapped to four of the five risk factors and not to the problem, 'risk for falls.' The Aurora "Risk for Falls" Constraint Group could be mapped to two of the five fall risk factors and not to the problem, 'risk for falls.' The only fall risk factor that mapped to the AHFS classification was the representational terms for the risk factor 'sleeping medications.'

The problem, 'risk for falls,' and the five selected fall risk factors were represented with a mixture of SNOMED CT, ICD-9 CM, vendor specific and site-specific terms within the study site's clinical information system. Nine of the twenty-four mapped SNOMED CT terms were not visible in the clinical information system and therefore could not be recorded by a clinician. Two site-specific terms representing cognitive impairment (disorientation and memory loss), were located in two separate flow sheet sections, but the structure of the terms did not match and the data did not flow from one flow sheet to the other.

With the standard and non-standardized mapped terms located in the clinical information system, machine-readable codes were identified for each that were retrievable in the electronic data warehouse. Not all clinical data from the

clinical information system was exported to the electronic data warehouse. SNOMED CT codes were not available for retrieval from the electronic data warehouse, but the ICD-9 CM terms were retrievable through corresponding ICD-9 CM codes and the machine-readable codes corresponding to the vendor and site-specific terms were identified with the help of a clinical information systems analyst. Data corresponding to the machine-readable codes, for the sample population, was requested from the electronic data warehouse. The problem, 'risk for falls,' was retrievable as a recorded Morse Fall Scale score of 45 or greater in the '*Nursing Flow Sheet'* section and was recorded among 64.7% of the hospital episodes. Relative to the ICD-9 CM terms, the fall risk factors recorded as vendor or site-specific terms located in the '*Nursing Flow Sheet'* and '*Orders*' sections were high. The recording of ICD-9 CM terms ranged from 0% (e.g. 'reactive confusion') to 3.2% (i.e. 'abnormality of gait').

While 'knowledge representation' of five selected fall risk factors and the problem, 'risk for falls,' with standardized terminologies was possible in this study, the use of standardized terminologies in the site's clinical information system is limited to two sections of the record, one of which is not accessible to all clinicians. While both the standardized and non-standardized terms were available in the electronic data warehouse for retrieval, non-standardized terms (which could be recorded by non-provider clinicians) were record more frequently than the standardized terms (which could only be recorded by providers).

Chapter 5 Discussion

The purpose of this study was to identify to what extent selected fall risk factors and the problem, 'risk for falls,' were represented in and retrievable from the patient's electronic health record in acute care. Specifically, this study sought to answer three questions: 1) How can the selected fall risk factors and problem, 'risk for falls' be represented through selected standardized terminologies? 2) How are the selected fall risk factors and problem, 'risk for falls' represented in a clinical information system? and 3) Which of the selected fall risk factors and problem, 'risk for falls' can be retrieved from the electronic health record?

Among patients in acute care, the five most commonly cited fall risk factors have been a history of falls, impaired gait, cognitive impairment, urinary incontinence, and the use of sleeping medications. The terms from the evidence that were found to represent these fall risk factors included medical diagnoses, nursing diagnoses, pharmacological agents and patient health history or assessment findings. Therefore, the five standardized terminologies selected for the research were diverse and used domain specific terminologies (NANDA-I, AHFS, ICD 9 CM), a reference terminology (SNOMED CT), and site-specific terminology (Aurora "Risk for Falls" constraint group located in USHIK). The following sections discuss the findings and conclusions for each of the three research questions and conclude with the study's limitations, implications for bedside clinicians, health system administrators, research and policy.

Research Question One: How can the selected fall risk factors and problem, 'risk for falls' be represented through selected standardized terminologies?

Discussion. The first research question focused on the knowledge representation component of the Knowledge Based Nursing Initiative (KBNI) framework. According to Lang et al. (2006), one of the five steps used to create 'actionable items' from knowledge is to translate the synthesized knowledge into data elements utilizing terms from a standardized terminology. Through a review of recent evidence, it was clear that a variety of terms have been utilized to represent the five selected fall risk factors and the problem, 'risk for falls' in patients' clinical records. This research question focused on how five fall risk factors and the problem, 'risk for falls,' could be represented with standardized terminologies. Using the representational terms from the evidence as key words, terminology mapping resulted in complete mapping of each of the five fall risk factors and the problem, 'risk for falls.'

NANDA-I. For this research, the NANDA-I diagnoses were mapped if any of the key words were located in the diagnoses name, definition or defining characteristics. The key words, 'impaired gait,' mapped to the term, 'gait changes,' located in list the defining characteristics for the diagnosis, 'Impaired Mobility.' Nevertheless, this does not appear to be a good match because the diagnosis 'Impaired Mobility' could represent the impaired mobility of only one extremity and therefore have no meaning related to gait. Impaired gait and impaired mobility are often discussed together as interchangeable concepts,

when referring to fall risk (Hook et al., 2008; Institute for Clinical Systems Improvement, 2010). Another NANDA-I diagnosis, 'Impaired Walking,' may have been a more appropriate match for 'impaired gait', but the term 'gait' was not included in the diagnosis name, definition or defining characteristics, hence it was not selected for this research. Upon review, the researcher recommends that if lexical matching is used in future research, only the diagnosis name be used to identify matching terms. Additionally, the development of an 'Impaired Gait' diagnosis for the NANDA-I taxonomy would assist in clarifying the differences between these two concepts.

SNOMED CT. While there was no preconceived notion that all five of the selected fall risk factors and the problem, 'risk for falls,' could be mapped to any single terminology, this was possible with the SNOMED CT terminology. This is not surprising given the domain specific terminologies that have been integrated within SNOMED CT (Lundberg et al., 2008; World Health Organizaiton, 2013). In fact, with over 311,000 active clinical concepts (International Health Terminology Standards Development Organisation, 2013a), the key word searches returned more terms than would be feasible for use within this research. The key word dementia alone returned 92 potential matches due to the various types of dementia, dementia screening exams and rating scales. The perfect lexical match, 'dementia (52448006)' has 14 child concepts, which could have also been mapped. While the granularity and hierarchical classification of SNOMED CT is beneficial to those whose research is seeking to answer questions about the prevalence of very specific clinical conditions, the depth may pose a challenge to

research related to more broadly defined topics, such as the prevalence of dementia among a specific population. Reich, Ryan, Stang and Rocca (Reich et al., 2012) described a similar issue in a study that was completed to evaluate the prevalence of eight medical conditions using the electronic data from two distinct health systems. The eight medical conditions were first defined by ICD-9 CM codes and then mapped to both SNOMED CT and Medical Dictionary for Regulatory Activities (MeDRA) terminologies before all coded data were extracted from the two databases. As a result of the cross mapping from ICD-9 CM to the two other terminologies, the prevalence of two of the eight health conditions was higher than identified by the ICD-9 CM codes alone (Reich et al., 2012).

ICD-9 CM. Similar search of the SNOMED CT terminology, using the key words 'dementia' and 'delirium' resulted in a number of potential matches, but other key words resulted in fewer potential matches than SNOMED CT. Given that ICD-9 CM is a terminology for classifying diseases and medical procedures (Centers for Disease Control and Prevention, 2012a), it is not surprising that the fall risk factor, 'sleeping medications,' represented by the terms, 'sedatives,' 'hypnotics' and 'CNS agents,' was not located except for conditions classifying adverse drug events such as poisoning.

Aurora "Risk for Falls." The Aurora, "Risk for Falls" Constraint Group included only those data elements and permissible values (terms) that represented the assessment of risk for falls, therefore representation of the problem, 'risk for falls,' was not located. The representational terms for 'history of

fall', 'cognitive impairment' and 'urinary incontinence' mapped to the permissible values of four of the thirty data elements in the group. The representational terms for the fall risks, 'sleeping medications' and 'impaired gait,' did not map to any of the data elements or permissible values. However, if a semantic mapping method had been utilized in conjunction with lexical mapping, several permissible values for the data element 'gait assessment' would have been selected. Permissible values for this data element included such terms as, 'staggering' and 'unsteady', which could semantically represent impaired gait or gait abnormality.

AHFS. The only fall risk factor that mapped to the AHFS Pharmacological classification was the representational terms for the risk factor 'sleeping medications.' Hypnotics, sedatives, and CNS agents were all cited as fall risk factors in the literature. While the three terms mapped to two medication classes in the AHFS Pharmacological classification system, the class representing 'sedatives' and 'hypnotics' also represented 'anxiolytics' and therefore was a less precise representation of the terms found in the literature.

Conclusions. The SNOMED CT terminology provided the most appropriate lexical matches and the most comprehensive mapping for each of the fall risk factors and the problem, 'risk for falls.' As discussed in the review of literature, fall risk factors include co-morbid diseases, conditions that are typically reviewed as part of the nursing assessment and specific medication classes. All located with the SNOMED CT terminology. The SNOMED CT terminology offers hundreds of thousands of concepts that have the ability to represent clinical terms across all health care domains, with varying levels of detail, and machine-

readable codes ready for electronic health record implementation (International Health Terminology Standards Development Organisation, 2013b). The SNOMED CT terminology is also recommended for use in capturing 'meaningful use' data (The International Health Terminology Standards Development Organisation, 2013) which provides additional impetus for the continued development and use of this terminology. It is this researcher's recommendation that nurse researchers seek more opportunities to not only validate the use of SNOMED CT terms to represent nursing collected patient data, but also seek opportunities to evaluate the use of SNOMED CT terms used in practice. This is not to say other terminologies should not be utilized to represent clinical concepts, but that the terminologies be developed and refined together, providing for cross-mapping of terms between terminologies.

Research Question Two: How are the selected fall risk factors and problem, 'risk for falls' represented in a clinical information system?

Discussion. The second research question also focuses on the 'knowledge representation' component of the KBNI framework. While the framework specifies that the 'knowledge' is represented with standardized terms in a machine-readable format in the clinical information system, this question sought to understand how 'knowledge' was represented in one clinical information system that was not constructed with benefit of the framework. While the implementation of standardized terminologies in electronic health records is an expectation (National Library of Medicine (U.S.). Board of Regents, 2006), the use of standardized terminology to represent nursing assessment, diagnosis,

intervention and evaluation data has been hampered by registered nurses lack of knowledge on the use of terminologies (Park & Cho, 2009), and the relative lack of the embedding of terminologies in the electronic health record to represent nursing practice (Jones et al., 2010; Park & Cho, 2009). In this research, despite utilizing five different and diverse terminologies, the only standardized terms that mapped to the study site's clinical information system with 100% matching were the terms from ICD-9 CM. While many of the SNOMED CT terms were visible in the '*Medical History'* and '*Problem List'* sections, nine were not visible, therefore, not available for the clinician to record. It appears that only those SNOMED CT terms with associated ICD-9 CM terms were available in the system for selection. Additionally, none of the SNOMED CT terms could be recorded independent of an ICD-9 CM term.

Among the remaining three standardized terminologies, lexically similar terms were located in the study site's clinical information system among the '*Nursing Flow Sheet,*' '*Rehabilitation Flow Sheet'* and '*Care Plan'* sections but none were exact matches, nor did any include corresponding terminological codes. While there were no NANDA-I diagnoses located in the clinical information system, the '*Care Plan'* section of the system did contain similarly labeled nursing problems that represented the problem, 'risk for falls,' and two of the five selected fall risk factors. Machine-readable codes were available for the nursing problems located in the '*Care Plan'* section.

More interesting was the variation among the non-standardized terms utilized to represent 'disorientation' and 'memory loss' in two sections of the

clinical information system. In the '*Nursing Flow Sheet'* section, disorientation could be recorded as the following: (1) disoriented to person; (2) disoriented to place; (3) disoriented to time; (4) disoriented x 4. However, in the '*Rehabilitation Flow Sheet'* section, disorientation could be recorded as disorientation to: (1) person; (2) place; (3) time; (4) situation; and (5) x 4. While these terms were similar, they were not exact lexical matches and were constructed in flow sheet rows with different machine-readable codes, so a term recorded in the nursing flow sheet did not carry over to the rehabilitation flow sheet and vice versa.

Conclusions. Despite the recommendation to use SNOMED CT to capture 'meaningful use' data, ICD-9 CM continues to be the primary standardized terminology embedded to capture patient data in the clinical information system. The additional use of a mixture of vendor and site-specific terms did not support interoperability across health systems and even within this one health system, across disciplines. Without the implementation of standardized terminologies, or at the very least consistent terminology, becoming 'meaningful users' of patient health care data will take tremendous effort. If multiple terms, with different machine-readable codes, can represent the same assessment or intervention data, the information system data analysts who are responsible for creating reports to evaluate patient quality metrics have to create massive reports to extract all possible documentation or risk missing the documentation. Many of the 2014 Clinical Quality Measures (CQMs) (Centers for Medicare and Medicaid, 2013) that hospitals are now required to report focus on metrics related to the prescription of specific medications for stroke, acute

myocardial infarction and venous thrombus embolism. However, with increased focus on the prevention of health-care acquired conditions, such as falls, future quality metrics may rely on nursing documentation, so implementation of standardized terminology is necessary for efficient and accurate measurement.

Research Question Three: Which of the selected fall risk factors and problem, 'risk for falls' can be retrieved from the electronic health record?

Discussion. The third research question focused on the sixth component of the KBNI framework, retrieval of data for analyses. According to the framework, data can be retrieved from either the clinical data repository or the data warehouse. This research analyzed the data contained within the data warehouse. The increased focus on improving the quality and efficiency of health care is compelling health systems to create electronic data warehouses in order to facilitate data analytics that combines data from different sources, such as financial, administrative, clinical, and patient satisfaction data (Murphy et al., 2013).

While the standardized terms mapped from SNOMED CT were visible in the study site's clinical information system, they were not retrievable from the electronic data warehouse. This may be because the SNOMED CT terms were only visible if they were linked to a corresponding ICD-9 CM term and only the ICD-9 CM terms were included in the electronic data warehouse. It is imperative to explore what data is contained in the electronic data warehouse in order to make thoughtful recommendations to what should be there. It is this researcher's recommendation that as the electronic data warehouse is continually being

improved, SNOMED CT terms and the corresponding SNOMED CT codes are added to improve the ability to document nursing's unique contributions to the assessment, diagnosis, management, and outcome measurement of patient conditions such as risk for falls.

While the ICD-9 CM terminology was embedded in the clinical information system in both the '*Problem List'* and '*Medical History'* sections, only the codes recorded in the '*Problem List'* were retrievable from the electronic data warehouse. During the mapping portion of this research, the researcher utilized simulated 'sign-in' codes, so that the electronic record could be accessed as if a physician or other prescriber had opened it and therefore, the physician/prescriber sections were visible. Therefore, it is presumed that only physicians/providers were responsible for the recording of all of the ICD-9 CM codes retrieved for this research. In contrast, other clinicians, including nurses, could record ICD-9 CM codes in the '*Medical History'* section. Unfortunately, ICD-9 CM codes recorded in the '*Medical History'* section were neither transported into, nor retrievable from, the electronic data warehouse. Additionally, the patient problems identified by nursing in the '*Care Plan'* section had machine-readable codes, but were not transported to the electronic data warehouse. Thus, the 'Problem List' was a 'Medical Problem List' rather than a 'Patient Problem List'. Nursing's contributions to the Problem List in this organization are invisible. Although it could not be completed with this research, the comparison between the ICD-9 CM codes recorded in the '*Problem List'*

section and the '*Medical History'* section would provide a better picture of 'who' is most likely to record the most comprehensive Patient Problem List.

Finally, while the ICD-9 CM terms located in the '*Problem List,'* the terms recorded in the *'Rehabilitation Flow Sheet'* and the terms in the *'Nursing Flow Sheet'* were not cross-mapped to each other, there were terms that appeared to overlap in meaning, but had very different recording rates. The term 'Urinary Incontinence' was retrieved from 3.1% of the records as an ICD-9 CM code, while it was retrieved from 16.5% and 17.6% of the records in two different areas of the '*Nursing Flow Sheet'* section. The terms representing 'cognitive impairment' and 'history of falls' showed similar rates of recording. Multiple ICD-9 CM terms represented 'cognitive impairment,' but the most frequently noted code, dementia, unspecified without behavioral disturbance (294.20), was only recorded in 1.8% of the records, while 'acute' or 'chronic' confusion was noted in 17.6% of the nursing documentation. The ICD-9 CM code of 'history of falls' was only noted on 1.4% of the records and the documentation of 'history of falls' in the nursing section was noted on 33.8% of the records.

Conclusions. Nursing documentation contains a richness of the patient's true condition that may be missed by other discipline's documentation, yet nursing contribution to the patients problem list, through documentation in the '*Medical History'* and '*Care Plan,'* is not being represented in the electronic data warehouses. On a positive note, nursing documentation of the five fall risk factors is represented in the electronic data warehouse. Although site-specific, as opposed to standardized terms were used, nursing assessment data was

available for retrieval and analyses. Future research will explore the representation of nursing interventions and outcomes related to falls and the availability of that data in the electronic warehouse.

Also, even though the rehabilitation flow sheet permitted standardized documentation of discrete terms related to disorientation or memory loss, these fields were not used. A decision had been made by the rehabilitation staff to use free text progress notes instead of discrete fields for ease of documentation input which does not facilitate subsequent data extraction for process improvement or research purposes.

Limitations

In order to keep this research feasible, not all lexical matches located key word searches in the ICD-9 CM and SNOMED CT terminologies were selected for inclusion in the mapping. Perhaps, if all terms had been mapped to and thereby retrievable from the data warehouse, the number of recorded ICD-9 CM codes representing each fall risk factor, such as cognitive impairment, would have been higher. In addition, due to the utilization of lexical mapping, terms that may have been a more appropriate match were not included. The researcher recommends using a combination of lexical and semantic mapping in future work. Finally, this research was conducted with data from one health system, which limits generalizability.

Implications for Bedside Clinicians

Variation of terms to represent the same clinical findings, limits interdisciplinary collaborative practice, such as the terms found to represent

disorientation and memory loss in this study. Bedside clinicians, regardless of discipline, need to collaborate with each other, information system analysts, and administrators to gain a better understanding of how standardized terminologies have been developed, how they are being used in practice, and the benefits of recording patients' clinical data in discrete fields. Subsequently, a clinical collaborative group should come to consensus on which and how standardized terminologies will be embedded into the clinical information system. Bowels et al. (2013) also recommends that nurses be taught the value of their documentation, which would likely contribute to better documentation and professional pride. Without collaboration from the bedside clinicians, alternative methods of recording clinical data will be utilized.

Implications for Health System Administrators

Watkins et al. (2009), points out that while it is the responsibility of each health care system's administration to decide which terminologies are embedded within documentation systems, "consistency of data, and ultimately interoperability, are necessary to serve patient-centered care, where health care information exist with many providers" (p. 325). While both ICD-9 CM and SNOMED CT terms were embedded in the study site's system, these terminologies were limited to the '*Medical History'* and '*Problem List'* sections of the record. In addition to the standardized terminology, the clinical information system had a combination of vendor and site specific terms embedded in the '*Nursing Flow Sheet*,' '*Rehabilitation Flow Sheet*,' '*Orders*,' and '*Care Plan'* sections of the record, which lead to variation within the clinical information

system. These variations lead to limited interoperability between disciplines within the same health system much less across health systems. A recent study described the issues related to conducting electronic health care research across four hospitals (Bowles et al., 2013). Despite having the electronic health record across the four health systems, comparison of nursing documented patient assessments was hampered due to local customization of terms, various versions of the clinical information systems and documentation policies differences between the four hospitals (Bowles et al., 2013). Health system administrators need to be cognizant of the consequences that occur when different sections of the clinical information system are embedded with inconsistent terms and must use consistent design principles across all disciplines to embed standardized, or at the very least consistent, terms.

While this research focused on the problem, 'risk for falls,' and five selected fall risk factors, the same methods could be utilized to map and retrieve data representing fall prevention interventions and outcomes, with the ultimate goal to improve outcomes. "Big healthcare data analytics" is the latest discussion topic at the national level. It refers to attempts to control health-care costs and, to improve patient care through evidence-based research (Kayyali, Knott, & Van Kuiken, 2013). Data analytics has been described as, "a process of reviewing large amounts of raw and unorganized data to identify patterns or trends that will help organizations better understand behavior and outcomes" (Murphy et al., 2013, p. 367). This process, enabled by the use of data warehouses that can store data from different data bases, is already being utilized by large health

systems to monitor performance, analyze trends, and improve health care (Murphy et al., 2013, p. 367). While it may have been possible to retrieve the patient data retrieved for this study from the clinical information system itself, if additional data, such as the fall event data recorded in the systems safety incident reporting system, is needed to evaluate outcomes, researchers will still need to extract data from two different databases. The development of electronic data warehouses, that can combine "raw and unorganized data" (Murphy et al., 2013).

Implications for Research

In this research, the problem, 'risk for falls,' and the five selected fall risk factors were found to be represented with standardized, vendor specific, and site specific terms which were retrievable from the electronic data warehouse. This research demonstrates that provided the terms can be located in the system, the re-use of electronic patient data for research is feasible. Controlling and tracking of the customization of site-specific terms coupled with the use of standardized terminologies can enable future research with existing patient data. Westra, White Delaney, Konicek, and Keenan (2008) discussed the importance of moving research beyond the development of nursing terminologies to both the evaluation of outcomes with secondary use of clinical data and to the support of interoperability. While the findings of this research support the need to continue to embed standardized terminologies into clinical information system, they also demonstrated that terms representing clinician recorded patient assessment data can be retrieved for analysis without manual, labor-intensive chart abstraction.

The recent research comparing the efficiency and accuracy of automated data extraction is promising (Byrne, Jordan, & Welle, 2013; Keenan et al., 2002) but few researchers use electronically extracted data for studies (Bowles et al., 2013).

Implications for Policy

While the recommendations to electronically represent patient data with standardized terminologies abound, (Bowles et al., 2013; Lang, 2008; Lundberg et al., 2008; National Library of Medicine (U.S.). Board of Regents, 2006, p. 44) patient data continues to recorded with non-standardized terms, inconsistent terms within systems and in multiple formats (discrete and text). This will continue to limit the interoperability of health information across systems. Edwards, Hollin, Barry, and Kachnowski (2010) propose that,

> "…the proliferation of regional health information organizations (RHIO) has occurred in response to the government encouragement, rather than eldership, of HIT [Health Information Technology] implementation thought the American Recovery and Reinvestment Act. While some systems have success in facilitating HIE [Health Information Exchange]…the prospectus for trans-national interoperability seems dime unless interfaces between each RHIO are built."

While policies mandating the implementation of standardized terminologies across disciplines is challenging due to competitive electronic health record vendors and disagreement about 'which'

standardized terminologies to use, without them, interoperability will continue to require the construction of resource intensive linkages between systems and extraction of data from many formats.

Summary

The diversity with which the problem, 'risk for falls,' and fall risk factors are represented in clinical records in acute care presents a challenge to efforts to compare research findings across sites. The purpose of this study was to identify to what extent selected fall risk factors and the problem, 'risk for falls,' were represented in and retrievable from the patient's electronic health record in acute care. The two components of the KBNI framework fit well with the purpose of this research. This research demonstrated that standardized terminologies can be used to represent (knowledge representation) the problem, 'risk for falls,' and the selected fall risk factors and that analyses of data from the electronic data warehouse can inform practice and be used for research. However, despite the benefits of interoperability and the ability to compare research across settings, there is continued use of vendor and site-specific terminologies and a limited use of SNOMED CT in the electronic health record.

In addition to the implementation and use of standardized terminologies, the retrieval of data from electronic data warehouses will enable researchers to contribute statistically-powered knowledge from large sample-sized studies, and will help health care administrators manage the business of health care. The use of data warehouses is not new, but with the advent of the electronic health record, the opportunities, and perhaps expectation, to utilize this method of data

extraction will soon become the norm. Health care organizations need to invest in business intelligence resources to create data inputs that enable meaningful data extraction and analysis. If we only record medicine's contribution to patient assessment, diagnosis, interventions, and outcomes, we will only explain a small portion of the variance in outcomes. If we have all disciplines contributions to patient assessment, diagnosis, interventions, and outcomes, we will be able to explain a much larger portion of the variance in outcomes. Nurses have to understand the value of their contribution to patient care outcomes and the quality of care. Likewise, health system and information systems administrators need to ensure nursing's contribution to patient care is recorded, collected, and stored in a meaningful way. Nurse researchers need to use that data "to advance the simultaneous transformation of practice and research (Lang, 2008).

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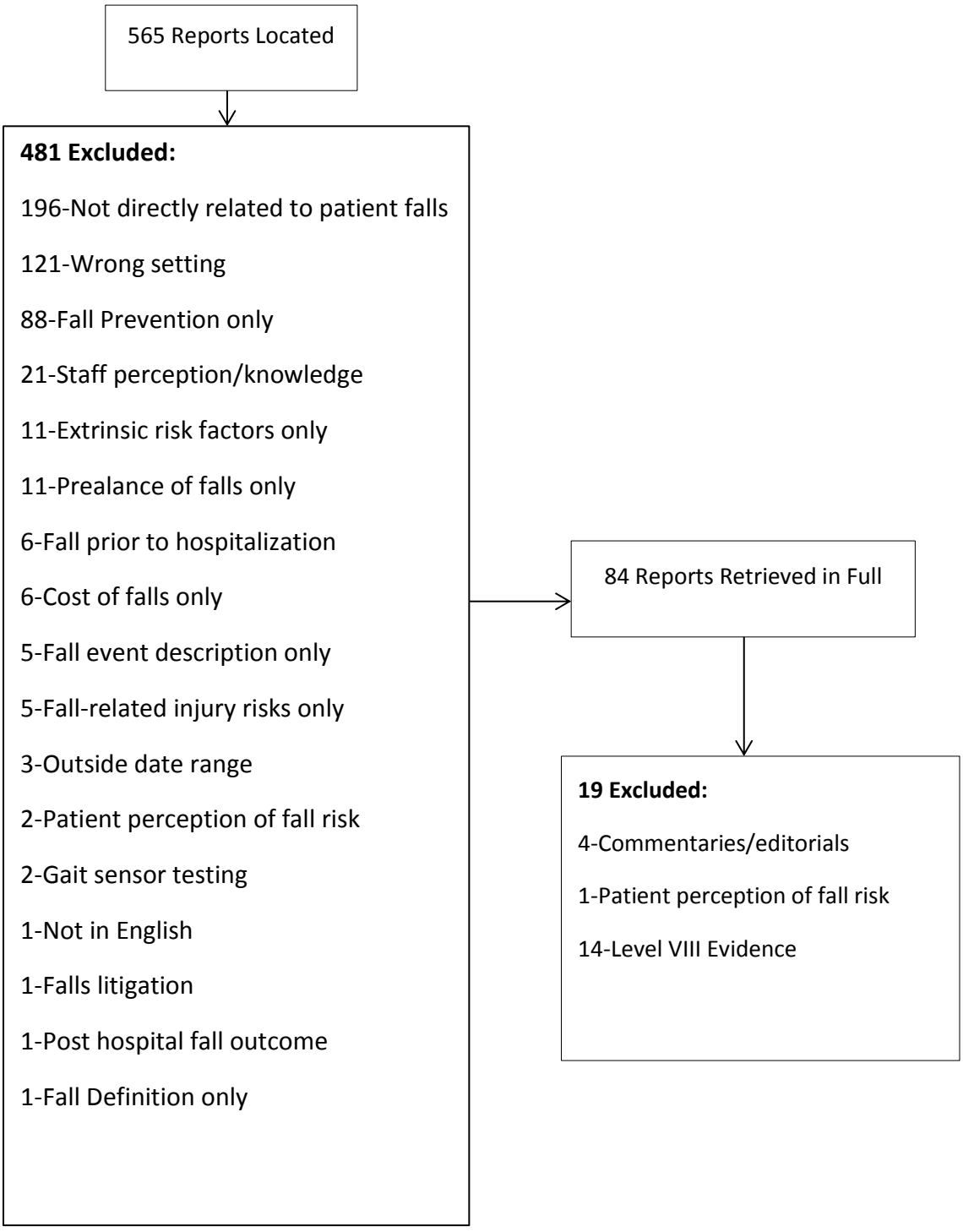
Appendix A



Appendix B

SNOMED CT and ICD-9 CM Search Returns

General Term	Representational Terms used as "Key Word" for Lexical Matching	SNOMED CT	ICD-9 CM
Risk for Falls	Potential for falls	0	0
	Low, medium, high risk for falls	1 (Risk for falls)	3
	Morse score 45 or greater	1 (Morse)	0
	STRATIFY score 2 or greater	0	0
History of Falls	Previous fall history	1 (History of fall)	0
	Presenting with a fall	0	0
	History of fall in past 3 months and/or this admission	0	0
	Fall in past 2 months	0	0
Impaired Gait	Weak gait pattern	0	0
	Gait abnormality	1	4 (Gait)
	Ataxia	72	10
Cognitive Impairment	Impaired mental status	13 (Mental status)	3 (Mental status)
	Dementia	92	29
	Delirium	28	7
	MMSE score	1 (MMSE)	0
	Senility and organic mental disorders	4 (Senility) 18 (Organic mental disorder)	2 (Senility) 1 (Organic mental disorders)
	Confusion	35	9
	Confused patient	4 (Confused)	0
	Impaired judgment/ lack of safety awareness	1 (Impaired judgment)	0
	Changes in mental status	13 (mental	3 (Mental status)

General Term	Representational Terms used as "Key Word" for Lexical Matching	SNOMED CT	ICD-9 CM
		status)	
	Disorientation (memory loss)	8 (Disorientation) 10 (Memory loss)	2 (Disorientation) 1 (Memory loss)
Urinary Incontinence	Urinary incontinence	24 97 (Incontinence)	5 16 (Incontinence)
	Urinary incontinent management	0	0
	Urinary elimination management	0	0
	Pt. reports getting wet or soiling self or incontinence	0	1 (Soiling)
Sleeping Medications	Sedatives	55	0
	CNS Agents	0	0
	Hypnotics	37	0

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EDUCATION

University of Wisconsin-Milwaukee, Milwaukee, WI
PhD in Nursing — **Current**

University of Wisconsin-Milwaukee, Milwaukee, WI
Master of Science in Nursing — **1999**

CNS Track with a focus on older adults and acute care

University of Wisconsin-Eau Claire, Eau Claire, WI
Bachelor of Science Nursing — **1992**

Graduated Cum Laude

CERTIFICATIONS

- Oncology Certified Nurse — **1995**
- ANCC Gerontological Nurse (BSN) Certification — **2001**
- ANCC Gerontological Nurse (APN) Certification — **2005**
- ANCC Gerontological Nurse (APN) Recertification — **2010**
- EPIC Credentialed Trainer (Inpatient) — **2011**

AWARDS

- Special Recognition Honor at the YWCA's 16th annual Women of Distinction Awards Luncheon — **2000**
- HealthCare Heroes: Advancements in Health Care 2004 Honoree: Small Business Times — **2004**

PROFESSIONAL ORGANIZATIONS

- Wisconsin Association of Clinical Nurse Specialist — **2009**
- Sigma Theta Tau-Eta Nu Chapter — **2011**
- American Nurses Association — **2013**

TEACHING EXPERIENCE

Marian College, Fond du Lac, WI
CNS Preceptor — **2003**

Concordia University, Mequon, WI
Preceptor for MS in Education Students — **2004, 2005 and 2007**

- Coordinated a variety of clinical experiences in settings that would most likely have student nurses.

University of Wisconsin, Milwaukee, WI
CNS Preceptor — **2007-2008 and 2009 to Present**

University of Wisconsin, Madison, WI
CNS Preceptor — **January 2008-May 2008**

Alverno College, Milwaukee WI
Preceptor for CNS/Nursing Education Student — **January 2008-December 2010**

RELATED EXPERIENCE

Waukesha Memorial Hospital, Waukesha, WI
Medical Surgical Clinical Nurse Specialist

Coordinator of Waukesha Memorial Hospital's "Nurses Improving Care to the Hospitalized Elderly" program

- Consultant, educator and clinical expert for professional and non-professional nursing staff — **1999 - Present**
- Consultant and educator in promotion of registered nurse professional development

Waukesha Memorial Hospital, Waukesha, WI
Staff Registered Nurse — **1992 - 1999**

- Experience with oncology patients, including the administration of chemotherapy
- Experience with a variety of medical patients with chronic and acute respiratory, gastrointestinal and endocrine disorders

- Experience with post-op care of vascular surgical inpatients

Publications and Presentations

- Poster Presentation "*Registered Nurses Knowledge and Attitudes Regarding Geriatric Care*". May 4th, 2001 Building Bridges to Research Based Practice: Enhancing Care Outcomes, Wisconsin.
- Presentation "*Restraint Reduction*". 2001 Annual Nurses Improving Care to the Hospitalized Elderly Leadership Conference, New York, New York.
- "The Geriatric Resource Nurse Model: A Culture Change" (2002) *Geriatric Nursing, 23*(3), 140.
- Poster Presentation "*Patients with Multiple Falls During Hospitalization*". November 13th, 2003, the 5th Annual Wisconsin Patient Safety Forum, Wisconsin.
- Poster Presentation "*Restraint Reduction*". May 13th, 2005, The 7th Annual Building Bridges to Research Based Nursing Practice: Enhancing Care Outcomes, Wisconsin.
- "*The Patient Focus*" presentation at Nurses Improving Care to the Health System Elderly Clinical Updates conference in 2006
- "Geriatric Resource Nurse Model", keynote address in 2006 for River Valley Health System in Fredericton, New Brunswick, Canada
- "*The Geriatric Resource Nurse Model*" co-presentation at Nurses Improving Care to the Health System Elderly Leadership conference in February 2007, New York New York.
- Poster presentation "Geriatric Resource Nurse Rounding". February 18th, 2008, NICHE Leadership Conference, Philadelphia, PA.
- "*The Geriatric Resource Nurse Model*" co-presentation at Nurses Improving Care to the Health System Elderly Leadership conference in February 2008, Philadelphia, PA.
- Poster presentation "Geriatric Resource Nurse Rounds on 5 Medical". May 9th, 2008. Southeastern Wisconsin Nursing Research Day, Milwaukee, WI.
- "Pain management through the ages: is there evidence to support the practice." ". May 9th, 2008. Southeastern Wisconsin Nursing Research Day, Milwaukee, WI.
- "The GRN Model." Panel Presentation. February 23rd, 2009. The NICHE Leadership Conference. Orlando, FL.
- "Innovative Initiatives in Caring for the Hospitalized Older Adult: ACE, HELP, NICHE" Co-presenter. May 8th, 2009. Southeastern Wisconsin Nursing Research Day, Milwaukee, WI.

- Co-presenter with Karen Smith, RPh at WCTC. May 10th, 2012. Topic was medication safety in older adults with a focus on medications related to falls.
- Poster Presentation. Co-Author with Kathy Mortenson, RN, CWOCN."Inter-rater Reliability with the Braden Scale", May 10th, 2012. Southeastern Wisconsin Nursing Research Day, Milwaukee, WI.
- Poster Presentation. Co-Author with Jane Smeaton, MSOLQ, RN. Standardizing Joint Replacement Care Across the Hospital Division. October 18-20th, 2012 Wisconsin Nurses Association Annual Meeting and Conference, Stevens Point, WI.