


# Risk of Medication Errors in the Home: An Integrative Literature Review

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Maria M. Crescenzi  
University of Central Florida

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RISK OF MEDICATION ERRORS IN THE HOME: AN INTEGRATIVE  
LITERATURE REVIEW

by

MARIA M. CRESCENZI

A thesis submitted in partial fulfillment of the requirements  
for Honors in the Major Program in Nursing  
in the College of Nursing  
and in the Burnett Honors College  
at the University of Central Florida  
Orlando, FL

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Thesis Chair: Dr. Angeline Bushy

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## **ABSTRACT**

Regardless of the setting, medication errors are of great concern when associated with an individual's health outcomes, along with the increased costs to society, healthcare institutions, and providers. Current research focuses on medication error data primarily in acute and extended care facilities. However, there is a paucity of research examining the causes of medication errors that occur post hospital discharge when individuals transition to the home. The purpose of this integrative literature review is to examine risk factors for medication errors outside of these settings, specifically in the home. A systematic literature search was conducted using multiple databases for relevant articles in the English language between 2006 to 2017, including CINAHL, MEDLINE, PubMed, and PsycINFO. Search terms included 'medication errors', 'home care', 'post-discharge', 'hospital readmission', and 'medication error risks in the home'. Exclusion criteria included medication errors in acute and extended care settings. The integrative review involved reading, analyzing and selecting articles, and summarizing on a matrix. Findings on occurrences of medication errors in the home included impaired client mental status, confusion related to medication names, limited understanding of medication purpose in the care plan and its side effects, level of health literacy, and client-provider miscommunication in discharge planning. Consistent and conflicting findings are discussed along with gaps in the literature. Limitations and implications for nursing practice, policy, research, and education are also noted.

## **DEDICATION**

For all nurses, using evidence-based practice  
to provide and uphold the standard of nursing care.

For my parents, Rich and Tina,  
who have continuously encouraged me to achieve my goals.

For my fiancé, Brent,  
who has endured and supported me throughout  
the completion of this thesis and the nursing program.

Finally, for my mentors, Dr. Angeline Bushy and Dr. Leslee D'Amato-Kubiet,  
who have inspired me with their wealth of nursing knowledge.

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## INTRODUCTION

According to reports by the Food and Drug Administration (FDA) (2009), medication errors impact approximately 1.3 million people in the United States each year. The FDA defines medication errors as any preventable event related to inappropriate medication use by health care professionals, clients, or consumers (2016). FDA's Adverse Event Reporting System (FAERS) was designed to provide information about known adverse events and medication errors; however, many errors are still underreported. A recent study lead by the Department of Surgery at Johns Hopkins University (2016) indicates that medical errors should rank as the third-leading cause of death in the United States. Members of the research team analyzed the Centers for Disease Control (CDC) current coding system records death certificate data. However, the CDC system does not account for certain types of medical errors, including errors related to medications, judgment, and communication (Allen & Pierce, 2016).

Medication errors are multifactorial, meaning that they are related to one or more factors and can occur under a variety of circumstances. There are five phases in the medication distribution system, including prescribing, repackaging, dispensing, administering, and monitoring (FDA, 2009). The potential for error exists in each of these phases and may occur under the supervision of physicians, nurses, pharmacists, and even families and caregivers, as well as by the individual taking the medication. Causes of medication errors are numerous and current research on this topic primarily focuses on errors that occur in acute and extended care settings, with minimal information addressing medication errors post discharge. Risks for medication errors, related to both acute and chronic conditions, made by individuals in the home after hospital discharge will be explored in this thesis. Specific risks will include age, cognitive



impairment, polypharmacy, client confusion about the name of medications, limited understanding about the medication in respect to the individual's care plan, level of health literacy, and discrepancies in provider-client communication.

## **BACKGROUND**

### **Medication errors: What are they?**

Medication errors are events involving inappropriate medication use and sometimes result in fatal consequences. Oftentimes these events could be averted with preventable measures. Medication errors include errors in prescribing, packaging, dispensing, administering, and monitoring, but exclude the development of side effects and adverse effects of medications (FDA, 2009). The difference is that medication errors are caused by mistakes in medical management while side effects and adverse effects develop because of the underlying condition of the client and the use of a chemical substance. Many medication errors are minor and do not result in serious injury to the client and most are preventable events, which could eventually lead to more devastating consequences.

### **Possible factors influencing the risk of medication errors**

#### **Non-Modifiable Risk Factors**

##### *Age*

Studies focusing on factors contributing to medication errors made by individuals in the home often associate older age with the development of multiple comorbidities, as well as the need for multiple medications and providers, and increasing cognitive impairment. Although these factors are not always attributed to older age, the older population often experiences these factors at a higher rate than younger populations. In addition, increasing age may alter the pharmacodynamics and pharmacokinetics of medications, which increases the risk of medication errors and identifies a need for education in this population. Therefore, age should be outlined as a possible factor influencing the risk of medication errors made by individuals in the home.

### ***Cognitive impairment***

Cognitive impairment often includes difficulty with memory, language, thinking, and judgment and is described as a decline greater than age-related changes (Mayo Clinic, 2016). Hain, Tappen, Diaz, and Ouslander (2012) suggest that even minor changes in cognitive function disrupts the ability to self-manage medications, which increases the risk for medication errors. Executive function and working memory are a part of cognitive function, which includes problem solving, planning, organizing schedules, and temporary storage to perform a task. Evidence suggests that these qualities are essential in successful management of medications and should be assessed prior to discharge from an acute care facility to reduce the risk of medication errors in the home (Hain et al., 2012).

### ***Polypharmacy***

Polypharmacy is the simultaneous use of multiple medications concurrently to manage coexisting health problems or to treat a single condition, which may or may not be prescribed, and is linked to the increase in risk for medication errors. Clients taking more than one medication at a time are at an increased risk for medication errors by the potential to consume the wrong drug or by drug-to-drug interactions that may occur when taking medications simultaneously. Medication errors can also occur if the client is prescribed medications from multiple providers or if multiple pharmacies are used to fill the prescriptions, as well as self-medicating with over-the-counter medications and other kinds of nontraditional pharmaceutical products, such as herbal remedies. Meredith et al. (2001) conducted a cross-sectional survey focusing on the frequency of medication errors that occurs in home healthcare clients age 65 and older. The study indicates a linear progression of medication errors that increases with the

increase in the number of medications taken simultaneously. The percentage of errors increases from 16% for those taking one to three drugs to 50% for those taking nine or more drugs (Meredith et al., 2001).

Polypharmacy is categorized as one of the non-modifiable risk factors in drug therapy that occurs in the home because many people are bound by their health insurance plans. Many consumers choose pharmacies based on cost and insurance coverage. Sometimes multiple medications are required to treat certain conditions and multiple providers are needed to monitor the condition under their specialty. Therefore, polypharmacy is considered non-modifiable although errors can be avoided through medication reconciliation and communication between providers and pharmacies.

### **Modifiable Risk Factors**

#### ***Client confusion related to medication names***

According to the Pennsylvania Patient Safety Advisory (2016), approximately 25% of the medication errors reported result from the confusion of drug names that look and sound alike. The reported errors mostly include those that have occurred in acute and extended care settings by health care professionals. One article concluded that the risk for error arises when different drugs have similar names, when one generic drug is marketed using multiple trade names, when the same brand name contains different drugs, and when drug names are abbreviated (Aronson, 2004). In the article, Aronson (2004) suggests that errors could be reduced if greater care is taken when naming new drugs and by proposing change to those drug names if errors occur. Currently, the research regarding medication errors related to medication names focuses on health care professionals rather than clients, which indicates a need for future research in this area.

### ***Discrepancies in provider-client communication***

Medication errors due to discrepancies in provider-client communication during discharge planning and instructions are multifactorial. Problems may arise due to lack of provider clarity, inappropriate medication prescription, low health literacy by the individual and caregiver, cognitive impairment, visual and/or auditory impairment, and more. Additionally, discrepancies in communication include the omission of medication by the individual without the health care provider's knowledge. Hale et al. (2015) concluded that 46% of the medication discrepancies were due to the omission of medication on the discharge list for various reasons, including cost, lack of transportation, inadequate insurance coverage, etc. Several studies suggest the use of medication review prior to discharge and medication reconciliation during follow-up appointments with the primary care provider or home health agency to reduce the risk of medication errors due to poor communication or a lack thereof.

### ***Health literacy***

Health literacy is defined as the degree to which an individual comprehends health information and the capacity to apply the information in order to make appropriate health decisions (CDC, 2015). The risk for medication errors due to the levels of health literacy may be related to miscommunication between provider and client, limited understanding of the care plan and drug therapy, or inadequate discharge teaching. Studies show that communication is important in all aspects of medication use and appropriate communication between those who prescribe, supply, administer, and consume can significantly reduce the risk of medication errors. Aronson (2004) suggests that health care providers should double-check their orders to ensure appropriate drug is prescribed for the client's condition. Also, pharmacists should check clients'

current medications to avoid any drug-to-drug interactions and clients should be familiar with the medications they are taking (Aronson, 2004). Currently, evidence suggests a correlation between low health literacy and medication errors; however, additional research is needed to determine the frequency of medication errors made by clients due to low health literacy.

### **Current prevention strategies for medication errors**

Medication review prior to discharge and medication reconciliation during follow-up appointments and consultations is currently a standard part of nursing practice. However, medication errors continue to impact individuals and their health outcomes, which indicates a need for future policy. Several studies propose the development and implementation of prevention strategies, including the evaluation of client and caregiver understanding of medication regimen before discharge, and education for home health nurses regarding comprehensive geriatric assessments and cognitive function. Self-management medication errors may also be reduced by individualizing the care plan to fit the client's needs, such as memory aids and once daily dosing for clients with memory impairments (Hain et al., 2012).

## **PROBLEM**

Medication errors are detrimental to the health outcomes of individuals, as well as impact the cost to society, health care institutions, and health care providers. According to Lahue, Pyenson, and Iwasaki (2012), medication errors impact nearly seven million people and contribute to 7,000 deaths each year in the United States. The overall costs to the health care system and society associated with preventable medication errors is estimated at more than \$21 billion annually (Lahue et al., 2012). Although these findings are significant, most of the evidence is based on medication error data that occurs within acute and extended care settings and does not include post hospital discharge data of medication errors that occur once the individual transitions to the home. Conducting studies associated with medication errors that occur by individuals in the home is more complex compared to tracking in-patient data reports. Medication errors occur in all settings; however, there is a paucity of current research that focuses on the specific risk factors and the incidence of medication errors post discharge by a client in the home. Consequently, lack of data poses a dilemma for identifying and preventing these types of errors within the home setting.

## **PURPOSE**

The primary purpose of this thesis is to present an integrative review of research literature from 2006 to 2017 to examine the risks associated with medication errors made by individuals in the home after hospital discharge. This review can provide a better understanding of possible risk variables for medication errors related to both acute and chronic conditions and evaluate the types of risk factors that increase the occurrence of medication errors post discharge. The secondary purpose of the research findings of this thesis is to identify factors that reduce the risk for medication errors and to highlight the need for future research regarding medication errors that occur specifically in the home. Further research is needed to confirm probable risk factors and to determine if interventions by healthcare professionals, such as health literacy focused discharge teaching, medication reconciliation, and follow-up discussions significantly reduce the occurrence of medication errors post discharge. Understanding risk factors for medication errors and factors that reduce the risk will help increase awareness about accurate medication administration in the home setting, medication reconciliation between providers and individuals, and drug therapy education offered during discharge from an acute care facility. Ultimately, the goal is to establish evidence-based interventions and prevention strategies that can be integrated into future nursing practice to reduce medication errors.



## METHOD

A search of relevant databases focused on medication errors in the home after hospital discharge included the National Center for Biotechnology Information (NCBI) database PubMed, PsycINFO, as well as two EBSCOhost databases, Cumulative Index to Nursing and Allied Health Literature (CINAHL) and Medical Literature On-line (MEDLINE) (Appendices: Figure 2: Consort Diagram of Thesis Methodology).

Key search terms included medication errors, home care, post-discharge, hospital readmission, and risks. Articles were limited to peer-reviewed articles from 2006 to the present. Seminal studies published prior to 2006 that provided a foundation for the current research were included in this review. In addition to the published articles, relevant material from current nursing textbooks, and accredited sources, such as the FDA and CDC, were used by the author to substantiate and enhance the findings of the research literature.

Each article was evaluated and individually critiqued for relevance to the topic and application to the proposed risk factors for medication errors made post-hospital by individuals within the home setting. In the appendices, Table 2 summarizes the findings for each article that was reviewed for this thesis. Subsequently, all the critiqued articles were synthesized by the researcher and key findings were extracted along with consistent and inconsistent findings and gaps in the literature. Limitations of the study and recommendations for future research also were noted.

## RESULTS

Of the twenty-four articles that were reviewed, twelve articles were directly relevant to the risk factors for medication errors in transition from hospital discharge to the home. Additional articles are cited that were supplementary to the evidence revealed in the twelve articles (Appendix: Table 2). Table 1 summarizes risk factors that were found in the literature along with the authors and years of the publication. Essentially, four citations suggest that advancing age increases the risk for medication errors made by individuals in the home. Five citations indicate that cognitive impairment affects the ability to self-manage medications and plays a role in the development of medication discrepancies. Another five citations focus on polypharmacy as one of the most prevalent factors when examining the causes of medication errors. Five other citations indicated confusing medication names, specifically look-alike and sound-alike medication names, are directly related to medication errors made by individuals and health care professionals. Four citations correlated medication errors and discrepancies in provider-client communication in transition from hospital to home. Finally, four citations examined individual's education level and health literacy as a risk factor related to self-management of medications.

Each of these studies related to specific risk factors is examined in subsequent sections of this thesis. Results have shown that medication error rates in home care are comparable or higher than those rates in studies of hospitalized clients (Walsh et al., 2015). The research examined throughout this thesis outlined potential risk factors increasing the medication error rates in the home setting. Although all were significant, the risk factors most associated with medication errors in the home were polypharmacy, cognitive impairment, and confusing drug names.

**Table 1: Summary of Risk Factors for Medication Errors, Authors & Publication Date**

<b>Risk Factors for Medication Errors</b>	<b>Supportive Articles for Risk Factor</b>	<b>Total Articles</b>
Age	(Bao et al., 2012), (Hale et al., 2013), (Hu et al., 2012), (Meredith et al., 2001)	4
Cognitive Impairment	(Bao et al., 2012), (Filik et al., 2006), (Hain et al., 2012), (Hu et al., 2012), (Schroeder et al., 2016)	5
Polypharmacy	(Bao et al., 2012), (Hain, et al., 2012), (Hale et al., 2013), (Hu et al., 2012), (Meredith et al., 2001)	5
Client confusion related to medication names	(Bryan et al., 2015), (Falik et al., 2006), (Hu et al., 2012), (Lambert et al., 1999), (Schroeder et al., 2016)	5
Discrepancies in provider-client communication	(Falik et al., 2006), (Hain et al., 2012), (Hu et al., 2012), (Kripalani et al., 2012)	4
Health Literacy	(Hale et al., 2013), (Hu et al., 2012), (Kripalani et al., 2012), (Walsh et al., 2015)	4

### **Age**

The cited studies in Table 1 describe increasing age as a risk factor for medication errors due to the development of comorbidities, polypharmacy, decline in cognitive function, and inappropriate medication use. Although these are not normal age-related changes, the risk increases with age; therefore, the risk for medication errors also increases. Inappropriate medication use, in this case, refers to discrepancies in prescribing medications for the older adult population. Multiple studies have shown that many older adults were prescribed a medication inappropriate for the older adult, thus leading to a medication error.

Bao et al. (2012) found that 38% of the older adult home health clients were taking at least one inappropriate medication. Another study revealed that of seventy clients, sixty-six (94%) had at least one medication discrepancy with a median number of five medication discrepancies per individual (Hale et al., 2015). However, Hale et al. (2015) also concluded that increased age was significantly associated with fewer medication discrepancies (IRR = 0.99,  $p <$

0.05), which is an inconsistent finding in relation to the remaining research. One study identified a correlation between older age and inappropriate medications and found that twenty participants (24.3%) were prescribed at least one inappropriate medication at discharge from an acute care facility (Hu et al., 2012). Meredith et al. (2001) identified older age as a risk factor for polypharmacy and the prescription of inappropriate medications and found that one-third of the home health clients had a medication discrepancy or were taking a medication that is inappropriate for an elderly individual.

### **Cognitive Impairment**

The cited studies in Table 1 indicate that cognitive impairment increases the risk for medication errors in the home. Studies have shown that cognitive impairment may decrease the older adult's ability to self-manage medications post-hospitalization. One study suggests that even minor changes in cognitive function may significantly affect the individual's ability to manage medications and found that the average number of medication discrepancies was three per individual (Hain et al., 2012). The Mini-Cog assessment tool was used in the study to help identify impairment in executive functioning, which is required for problem solving, planning, and organizing schedules, and is essential for managing medications independently (Hain et al., 2012).

### **Polypharmacy**

Polypharmacy is consistently one of the highest risks for medication errors, especially by individuals in the home. The cited studies in Table 1 consider polypharmacy when examining the causes of medication errors and discussing possible interventions and prevention strategies. One study determined that the participants were taking, on average, eleven medications, with 21%

taking fifteen or more medications (Bao et al., 2012). Another study determined that fifty-one participants (67.1%) had at least one medication discrepancy (Hu et al., 2012). The same study showed that polypharmacy is the only factor associated with both inappropriate medication use and medication discrepancies (Hu et al., 2012). Results demonstrated a positive correlation with the frequency of medication errors and the number of medications taken (Meredith et al., 2001).

### **Client confusion related to medication names**

The cited studies in Table 1 discuss the confusion between look-alike and sound-alike medications that increase the risk for medication errors. According to Bryan et al. (2015), the stems used to show pharmacological similarity are often spelled inconsistently and some drugs are not appropriately paired; therefore, the potential for errors is increased significantly. Falik et al. (2006) examined the use of tall man lettering to determine if medication names will be less confusable in memory with the intervention. Although the results showed an increase in attention, there was no significant improvement in recognition memory (Falik et al., 2016). Lambert et al. (1999) proposed a benefit in the integration of confusing medication names in software warning systems to remind health care professionals of the increased risk for medication errors with certain medications. According to Schroeder et al. (2016), there is a strong and significant association between drug name confusion error rates in the real world and in laboratory-based test of memory and perception.

### **Discrepancies in provider-client communication**

The cited studies in Table 1 focus on discrepancies in provider-client communication that may increase the risk for medication errors in transition from hospital to home. Falik et al. (2006) found that the use of tall man lettering does not automatically make it easier to differentiate

between look-alike and sound-alike medication names. However, tall man lettering can be an effective method of reducing medication errors if individuals understand its purpose, which indicates a need for provider-client communication and education about labeling techniques (Falik et al., 2006). Hale et al. (2015) found that 46% of the medication discrepancies were omissions of a medication on the discharge list. The reasons for the omissions were not clearly defined; however, discrepancies in provider-client communication are suspected. Some theories outlined in the study include cost, inadequate insurance coverage, lack of transportation to the pharmacy, the individual's misinterpretation of discharge instructions, and the provider's inadequate discharge teaching and medication review (Hain et al., 2015). One study showed that medication errors were not significantly reduced by interventions aimed at improving medication reconciliation and counseling, indicating a need for further research to develop prevention strategies for medication errors (Kripalani et al., 2012).

### **Health Literacy**

The cited studies in Table 1 evaluated the risk of medication errors in relation to an individual's level of health literacy. One study found that medication errors were present among approximately 50% of the study participants with low health literacy (Kripalani et al., 2012). Another study suggests that higher health literacy is associated with more omissions of medication (IRR = 1.85,  $p < 0.05$ ), which either indicates an inconsistency in the research findings or an individual's knowledge of inappropriate medications in the plan of care (Hale et al., 2013). Hu et al. (2012) examined medication discrepancies in older Chinese Americans and determined that low education and health literacy, along with language barriers, increased the risk of medication errors in the study participants.

## **DISCUSSION**

The studies examined for this thesis provide important data regarding medication errors made post-hospital to the home. Non-modifiable and modifiable risk factors for medication errors were proposed, although not clearly defined in the current literature. This review of the literature serves as preliminary evidence for future research focusing on the prevention of medication errors in the home setting. The results repeatedly demonstrate that risk for medication errors that occur in the home often are preventable, specifically risk associated with prescription, labeling, administering, and monitoring that impact individuals and the health care system.

### **Non-modifiable risk factors**

Prescription errors include inappropriate medications and/or dosages prescribed for the older adult. However, inconsistent findings regarding increasing age and fewer medication discrepancies indicates a need for further review. Results emphasize the importance of cognitive function assessment tools used in home health nursing to evaluate an individual's ability to self-manage medications. In addition, polypharmacy remains one of the highest risks for medication errors because of the positive correlation with increasing the number of medications.

### **Modifiable risk factors**

Based on the results, the most popular and most researched intervention for confusing drug names is the use of tall man lettering on labeling. The evidence suggests a beneficial outcome if individuals are aware of the purpose of tall man lettering. Another significant intervention outlined involves the use of software to compare proposed medication names to existing names to screen for similarities. Although one study concluded that medication errors were not significantly reduced with the use of medication reconciliation and counseling, there is

a gap in the literature that excludes information about specific counseling methods and discharge teachings regarding home medication administration. It is not clear if the interventions were appropriately exercised, which indicates a need for further research on prevention strategies. In order to individualize care and provide appropriate materials for the client, the nurse should assess language barriers, health literacy skills, and level of education prior to offering education, counseling, and discharge teaching.



## **IMPLICATIONS FOR NURSING**

Based on this integrative review, the next sections highlight implications for nursing practice, policy, research, education, and study limitations.

### **Practice**

The results of this integrative review of literature have several implications for nursing practice. Donze et al. (2013) developed a computerized algorithm that can be used to predict avoidable 30-day readmission in clients with high risk health-related conditions as a way to lower health care costs and reduce hospital readmission rates. The assessment tool could be used in nursing practice to predict an individual's need for an increase in the level of transitional care. Nurses could also use educational and memory aids for individuals experiencing cognitive impairment to reduce self-management errors post-hospitalization. Nurses should also adhere to strict medication reconciliation guidelines to ensure proper indication of each medication. Individual and caregiver instruction focusing on medication administration can be incorporated in to discharge planning, then reviewed by nurses who provide care in the home. A person's understanding and skill level should be assessed through verbatim repetition of the drug therapy instruction along with return demonstrations.

### **Policy**

At the national level, specific policy changes are needed that focus on medication reconciliation protocols, the reporting of medical errors, and reducing risks that contribute to medication errors in the home. Internationally, the World Health Organization should be encouraged to reevaluate the international non-proprietary pharmaceutical naming system in an effort to minimize similarities in product nomenclature. Finally, at the local level, hospital

policies should consider implementing warning systems within the electronic medical record (EMR) to remind health care providers of confusing drug names and dosages.

### **Research**

Current research primarily focuses on medication errors that occur in acute and extended care settings, with minimal information addressing medication errors made by individuals in the home. Further nursing research is needed regarding the prevalence of medication errors that specifically occur in the home, to substantiate actual and potential risk factors for medication errors outside of acute and long-term care settings, and to identify and integrate prevention strategies. Studies involving larger randomized samples with diverse populations in the home context are needed in order to generalize the findings on medication errors; and, to tailor prevention strategies, the needs, and preferences of populations who are at particular risk for such events.

### **Education**

Education implications aimed at medication administration in the home have a two-fold purpose, that focuses on health professionals and the individual taking medications in the home setting. Students in health-related disciplines must be educated about the risks and prevalence of medication errors outside of acute and extended care settings. Nurses must conscientiously focus on accurate medication reconciliation practices that fit an individual's level of health literacy and cultural preferences. Teaching is a critical component of discharge planning; however, evaluating a client and his or her caregiver's understanding and skill level related to medications are of equal importance. Discharge planners and home health nurses should incorporate

comprehensive geriatric assessments, including evaluation of cognitive status to identify actual and potential risks for impaired self-care and self-management in the home setting.

## **LIMITATIONS**

Several limitations were noted in this integrative review of the literature. The initial search results revealed numerous potentially relevant articles (i.e., keywords included medication errors, home care, post-discharge, hospital readmission, and risks). However, only twelve research articles met the inclusion criteria and were relevant to the purpose of the investigation focusing on post hospital discharge medication errors that occurred in the home setting. Of the twelve research articles reviewed, only six (50%) included a sample size larger than 1,000 subjects. The absence of research articles focusing on medication errors in the home setting, small sample sizes, and absence of information on particularly vulnerable subpopulations limit the generalizability of the findings. These limitations provide a wide range of research topic areas for nurses.

## **SUMMARY**

The purpose of this integrative review of recent research literature was to identify risk factors that contribute to the occurrence of medication errors post hospital discharge by individuals in the home setting. A secondary purpose was to determine whether interventions by health care professionals, such as health literacy focused discharge teaching, medication reconciliation, and follow-up discussions significantly reduce the occurrence of medication errors post-hospitalization. The results of this review were found to be inconclusive, although compelling arguments were proposed for select risk factors. Finally, based on this review, implications for nursing and limitations to the reviewed studies were highlighted.

## **APPENDIX A**

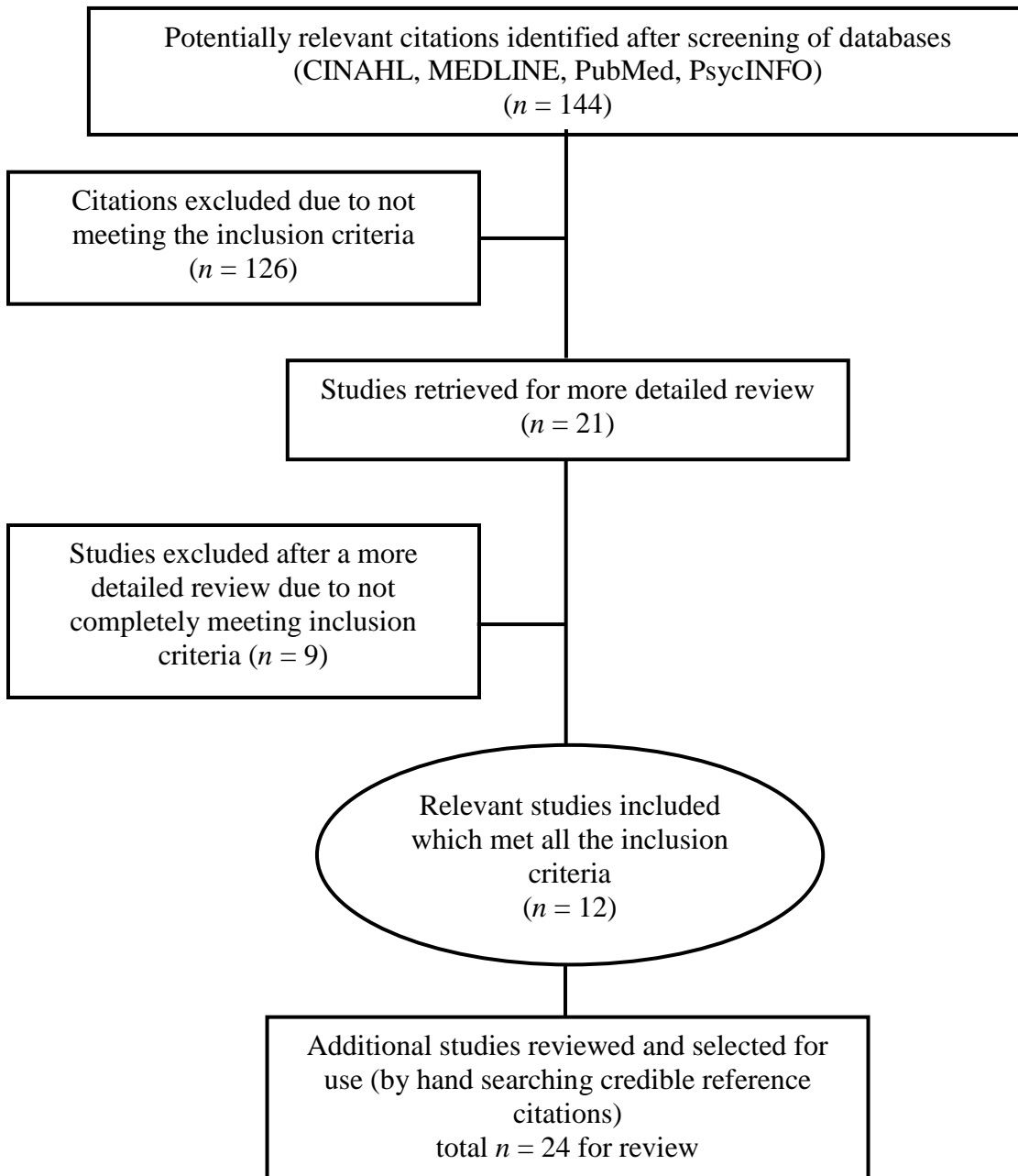
**Figure 1: Consort Diagram of Thesis Methodology**

**Figure 1: Consort Diagram of Thesis Methodology**

Flow Diagram of Study Selection Process

Key Search Terms = medication errors, home care, post-discharge, hospital readmission, risks

Limiters = English language, peer-reviewed, publication date from 2006 to present



## **APPENDIX B**

**Table 2: Table of Evidence of Reviewed Literature**



**Table 2: Table of Evidence of Reviewed Literature**

Article	Design	Population	Purpose	Significant Risk Factors	Key Findings	Nursing Implications
<p>Bao, Y., Shao, H., Bishop, T. F., Schackman, B. R., Bruce, M. L., Bao, Y., . . . Bruce, M. L. (2012). Inappropriate medication in a national sample of US elderly patients receiving home health care. <i>JGIM: Journal of General Internal Medicine</i>, 27(3), 304-310. doi:10.1007/s11606-011-1905-4</p>	<p>Cross-sectional analysis study  2007  Data from National Home and Hospice Care Survey</p>	<p>N: 3,124  Age &gt; 65  Home health clients taking at least one medication</p>	<p>To identify and estimate the frequency of potential inappropriate medication usage in older adult home health clients in the U.S.</p>	<p>Polypharmacy  Functional impairment  Age &gt; 65</p>	<p>Results show high incidence of inappropriate medications used in older adult populations despite mechanisms to improve safety such as medication reconciliation.</p>	<p>Future policies may be implemented to improve medication reconciliation processes in home health care agencies to lower the incidence of medication errors related to inappropriate medication use in the older adult population.</p>

Article	Design	Population	Purpose	Significant Risk Factors	Key Findings	Nursing Implications
<p>Bryan, R., Aronson, J. K., ten Hacken, P., Williams, A., &amp; Jordan, S. (2015). Patient safety in medication nomenclature: Orthographic and semantic properties of international nonproprietary names. <i>Plos One</i>, 10(12), e0145431-e0145431. doi:10.1371/journal.pone.0145431</p>	<p>Systematic Review</p> <p>Guidelines of World Health Organization (WHO)</p> <p>Microsoft Excel for analysis including calculation of Levenshtein edit distance (LED)</p>	<p>N: 7,987</p> <p>International Non-proprietary Names (INNs)</p>	<p>To explore the medication name designation process and to identify properties of names that may increase the risk for drug name confusion.</p>	<p>Look-alike and sound-alike medication names</p>	<p>Compliance with the naming guidelines provided by the World Health Organization (WHO) was inconsistent.</p> <p>The stems used to show pharmacological similarity are often spelled inconsistently and some drugs are not appropriately paired.</p>	<p>Inconsistent pairings of international non-proprietary names increase the potential for confusion.</p> <p>The stem system and WHO guidelines for drug naming should be further examined to reduce similarities in nomenclature to prevent errors related to drug name confusion.</p>

Article	Design	Population	Purpose	Significant Risk Factors	Key Findings	Nursing Implications
<p>Donze, J., Aujesky, D., Williams, D., &amp; Schnipper, J. L. (2013). Potentially avoidable 30-day hospital readmissions in medical patients. <i>JAMA Internal Medicine</i>, 173(8), 632-638. doi:10.1001/jamainternmed.2013.3023</p>	<p>Retrospective cohort study  July 2009 – June 2010</p>	<p>N: 10,731  Client discharges from any medical services  30-day hospital readmission to three hospitals of the Partners Healthcare Network  Academic Medical Center in Boston, MA</p>	<p>To derive and validate a prediction model for avoidable 30-day hospital readmissions in medical clients for use prior to discharge.</p>	<p>HOSPITAL score: Hemoglobin at discharge, discharge from an Oncology service, Sodium level at discharge, Procedure during the index admission, index Type of admission, number of Admissions during the last 12 months, and Length of stay.</p>	<p>This retrospective cohort study suggests fair discriminatory power and fair calibration of the HOSPITAL score to identify the risk of avoidable 30-day hospital readmissions in medical clients. One fourth of the clients were classified as high risk for 30-day hospital readmission. The use of administrative and clinical data available prior to discharge may help identify at risk clients before discharge.</p>	<p>Implementing effective interventions to reduce hospital readmissions are often expensive.  The use of a validated computerized algorithm to predict avoidable 30-day readmission in medical clients may target high risk clients to keep costs low while reducing hospital readmission rates.  The HOSPITAL score may identify clients in need of more intensive transitional care.</p>

Article	Design	Population	Purpose	Significant Risk Factors	Key Findings	Nursing Implications
<p>Filik, R., Purdy, K., Gale, A., &amp; Gerrett, D. (2006). Labeling of medicines and patient safety: Evaluating methods of reducing drug name confusion. <i>Human Factors</i>, 48(1), 39-47.</p>	<p>Randomized controlled trial</p> <p>Analysis of variance (ANOVA)</p>	<p>N: 68</p> <p>Staff and students from University of Derby</p> <p>Non-healthcare professionals</p>	<p>To evaluate the use of tall-man lettering and color as an intervention to reduce medication errors related to confusing drug names.</p>	<p>Look-alike and sound-alike medication names</p> <p>Poor handwriting on prescriptions</p> <p>Similar packaging and labeling (same manufacturer)</p> <p>Similarly named drugs with similar strengths and indications</p> <p>Environmental factors: noise, lighting conditions, and distractions</p> <p>Cognitive impairment (memory)</p>	<p>The use of tall man lettering does not automatically make it easier to differentiate between look-alike and sound-alike medication names.</p> <p>However, tall man lettering can be effective if participants understand its purpose.</p> <p>The tall man intervention may increase attention, but does not make names less confusable with each other in memory.</p>	<p>Patient safety: use tall man lettering on packaging, labeling, computer software, and on shelf labels in pharmacies to reduce medication errors related to look-alike and sound-alike name confusion.</p>

Article	Design	Population	Purpose	Significant Risk Factors	Key Findings	Nursing Implications
<p>Hain, D. J., Tappen, R., Diaz, S., &amp; Ouslander, J. G. (2012). Cognitive impairment and medication self-management errors in older adults discharged home from a community hospital. <i>Home Healthcare Nurse</i>, 30(4), 246-254. doi:10.1097/NHH.0b013e31824c28bd</p>	<p>Pilot study January 2009 – June 2009</p>	<p>N: 1,200  Post-hospitalized clients recruited from a 400-bed community hospital in Southeast Florida</p>	<p>To explore the relationship between medication errors and cognitive impairment in recently discharged older adults.</p>	<p>Cognitive impairment  Transition from hospital to home  Self-management of medications: insufficient money, inadequate insurance coverage, lack of transportation to pharmacy  Misunderstanding of discharge instructions</p>	<p>The findings suggest that even minor changes in cognitive function affect the ability to self-manage medications in this older adult population. The Mini-Cog assessment tool may help identify impairment in executive functioning, which is required for problem solving, planning, and organizing schedules. Medication discrepancies per individual averaged about three.</p>	<p>Education for home health nurses regarding comprehensive geriatric assessments including evaluation of cognitive status may help identify self-management errors in medication regimens. Further research may explore specific strategies to reduce self-management errors in older adults with changes in cognitive function (individualized care, memory aids, once daily dosing, etc.)</p>

Article	Design	Population	Purpose	Significant Risk Factors	Key Findings	Nursing Implications
<p>Hale, J., Neal, E. B., Myers, A., Wright, K. H. S., Triplett, J., Brown, L. B., . . . Mixon, A. S. (2015). Medication discrepancies and associated risk factors identified in home health patients. <i>Home Healthcare Now</i>, 33(9), 493-499. doi:10.1097/NHH.0000000000000290</p>	<p>Retrospective observational study 2015</p>	<p>N: 70  Adults discharged from an academic medical center  Affiliated home healthcare agency</p>	<p>To identify medication discrepancies between discharge and the first home healthcare visit and to evaluate the risk factors associated with these errors.</p>	<p>Increasing age  Low health literacy of individuals  Medication discrepancies</p>	<p>66 out of 70 (94%) participants had at least one medication discrepancy.  Median number of medication discrepancies per individual was five.  46% of the medication discrepancies were omissions of a medication on the discharge list.</p>	<p>Determining the type, frequency, and reason for medication discrepancies may help establish appropriate interventions and strategies to reduce medication errors in the home.</p>

Article	Design	Population	Purpose	Significant Risk Factors	Key Findings	Nursing Implications
<p>Hu, S. H., Capezuti, E., Foust, J. B., Boltz, M. P., Kim, H. (2012). Medication discrepancy and potentially inappropriate medication in older Chinese-American home-care patients after hospital discharge. <i>American Journal of Geriatric Pharmacotherapy</i>, 10(5), 284-295. <a href="http://dx.doi.org/10.1016/j.amjopharm.2012.08.001">http://dx.doi.org/10.1016/j.amjopharm.2012.08.001</a></p>	<p>Cross-sectional analysis study June 2010 – July 2011 2002 diagnosis-independent Beers criteria</p>	<p>N: 82 Older Chinese Americans Recruited from large, nonprofit home healthcare agency in New York City</p>	<p>To examine the frequency of inappropriate medication use and medication discrepancy in the older adult Chinese American population in transition from hospital to home.</p>	<p>Polypharmacy Age &gt; 65 Inappropriate medication use Medication discrepancies Language barriers Cognitive impairment Low education and health literacy Length of hospital stay</p>	<p>20 participants (24.3%) were prescribed at least one inappropriate medication at the time of discharge. 51 participants (67.1%) had at least one medication discrepancy. Older age and length of hospital stay increase the risk of inappropriate medication use. Polypharmacy is the only factor associated with both inappropriate medication use and medication discrepancies.</p>	<p>This study suggests that health care providers should not only reconcile medication inconsistencies during transition from hospital to home, but also the appropriateness of medications in certain populations.</p>

Article	Design	Population	Purpose	Significant Risk Factors	Key Findings	Nursing Implications
<p>Kripalani, S., Roumie, C. L., Dalal, A. K., Cawthon, C., Businger, A., Eden, S. K., . . . Schnipper, J. L. (2012). Effect of a pharmacist intervention on clinically important medication errors after hospital discharge: A randomized controlled trial. <i>Annals of internal medicine</i>, 157(1), 1-10. doi:10.7326/0003-4819-157-1-201207030-00003</p>	<p>Randomized controlled trial with concealed allocation and blinded outcome assessors</p>	<p>N: 851  Adults hospitalized with acute coronary syndromes or acute decompensated heart failure  Two tertiary care academic hospitals</p>	<p>To determine the effect of the pharmacist intervention for low health literacy in cardiovascular disease on the occurrence of medication errors after hospital discharge.</p>	<p>Non-adherence to medications  Medication discrepancies  Low health literacy</p>	<p>Medication errors were present among half of the participants after hospital discharge.  Medication errors were not significantly reduced by the pharmacist intervention, which included pharmacist medication reconciliation, inpatient pharmacist counseling, low health literacy adherence aids, and individualized telephone follow-up after discharge.</p>	<p>Emphasize medication adherence and clarify medication discrepancies in discharge teaching.  Evaluate client understanding of medication regimen before discharge.</p>



Article	Design	Population	Purpose	Significant Risk Factors	Key Findings	Nursing Implications
<p>Lambert, B. L., Lin, S. J., Chang, K. Y., &amp; Gandhi, S. K. (1999). Similarity as a risk factor in drug-name confusion errors: The look-alike (orthographic) and sound-alike (phonetic) model. <i>Medical Care</i>, 37(12), 1214-1225.</p>	<p>Case-control study</p> <p>Twenty-two different computerized measures of orthographic similarity, orthographic distance, and phonetic similarity</p> <p>Univariate and multivariate logistic regression models</p> <p>Tenfold cross validation</p>	<p>N: 2,254</p> <p>1,127 cases 1,127 controls</p> <p>Cases include pairs of medication names that appeared in published errors reports or national error databases</p>	<p>To evaluate prognostic tests of medication name confusion, including sensitivity, specificity, and overall accuracy.</p>	<p>Look-alike and sound-alike medication names</p> <p>Similar packaging and labeling (same manufacturer)</p> <p>Similarly named drugs with similar strengths and indications</p>	<p>All 22 computerized measures of similarity were significant risk factors for medication errors.</p> <p>Three-predictor logistic regression model cross-validated sensitivity of 93.7%, specificity of 95.9%, and accuracy of 94.8%.</p>	<p>This study suggests that using a sensitive and specific test for drug-name confusion can prevent medication errors by integrating confusing name pairs into software warning systems for health care providers.</p> <p>This study also suggests the development of a reference-standard database of names to screen proposed medication names against already existing drug names to reduce similarity.</p>

Article	Design	Population	Purpose	Significant Risk Factors	Key Findings	Nursing Implications
<p>Meredith, S., Feldman, P. H., Frey, D., Hall, K., Arnold, K., Brown, N. J., &amp; Ray, W. A. (2001). Possible medication errors in home healthcare patients. <i>J Am Geriatr Soc</i>, 49(6), 719-724.</p>	<p>Cross-sectional survey</p> <p>October 1996 – September 1998</p>	<p>N: 6,718</p> <p>Age &gt; 65</p> <p>Two of the largest home healthcare agencies in the U.S.</p>	<p>To determine the frequency of medication errors in a population of older adults using expert panel objective criteria.</p>	<p>Polypharmacy</p> <p>Age &gt; 65</p> <p>Inappropriate medications prescribed for older population</p>	<p>This study suggests that the frequency of medication errors is positively correlated with the number of medications taken.</p> <p>One third of the home healthcare clients experienced a medication error or were prescribed a medication inappropriate for the older adult population.</p>	<p>Home healthcare nurses should reconcile medications and investigate each medication to ensure correct indication.</p> <p>Avoid polypharmacy if possible.</p>

Article	Design	Population	Purpose	Significant Risk Factors	Key Findings	Nursing Implications
<p>Schroeder, S. R., Salomon, M. M., Galanter, W. L., Schiff, G. D., Vaida, A. J., Gaunt, M. J., . . . Lambert, B. L. (2016). Cognitive tests predict real-world errors: The relationship between drug name confusion rates in laboratory-based memory and perception tests and corresponding error rates in large pharmacy chains. <i>BMJ Quality &amp; Safety</i>, 1-13. doi:10.1136/bmjqs-2015-005099</p>	<p>Randomized controlled trial  2016</p>	<p>N: 80  Doctors, nurses, pharmacists, technicians, and lay people</p>	<p>To evaluate the relationship between real-world medication name confusion errors rates and laboratory-based error rates in medication name memory and perception.</p>	<p>Look-alike and sound-alike medication names  Short term memory  Visual and auditory perception</p>	<p>At the time, this study was the first to demonstrate a significant association between real-world error rates and any method of preapproval name testing.  Laboratory-based error rates significantly predicted real-world error rates from an outpatient pharmacy chain.</p>	<p>Evidenced-based laboratory tests of memory and perception are inexpensive and simple to use to screen proposed drug names to reduce the frequency of medication errors related to name confusion.</p>

Article	Design	Population	Purpose	Significant Risk Factors	Key Findings	Nursing Implications
<p>Walsh, K. E., Roblin, D. W., Weingart, S. N., Houlahan, K. E., Degar, B., Billett, A., . . . Mazor, K. M. (2013). Medication errors in the home: A multisite study of children with cancer. <i>Pediatrics</i>, <i>131</i>(5), 1405-1414. doi:10.1542/peds.2012-2434</p>	<p>Prospective observational study</p> <p>November 2007 – April 2011</p>	<p>N: 92</p> <p>Children with cancer undergoing chemotherapy</p> <p>Three pediatric oncology clinics in the southeastern and northeastern United States</p>	<p>To identify the types of medication errors that occur in the home management of children with cancer.</p>	<p>Low health literacy of caregivers</p> <p>Inappropriate medication administration</p>	<p>This study of outpatient pediatric cancer care suggests medication error rates that were comparable or higher than those rates found in studies of hospitalized clients.</p> <p>Non-chemotherapy medications were more often involved in medication errors than chemotherapy.</p>	<p>Incorporate family teaching about medication administration and offer follow-up teachings.</p> <p>Evaluate client and caregiver understanding through demonstration of medication administration.</p>

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