

A Dissertation  
entitled  
Nurses' Perceptions of and Experiences with Medication Errors

by  
Mary Jo Maurer

Submitted as partial fulfillment of the requirements for  
the Doctor of Philosophy in Health Education

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August 2010

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The purpose of this study was to explore the relationship between nurse characteristics and medication errors. The study examined nurses' perceptions of factors which contribute to medication errors; barriers to reporting and factors that increase the reporting of medication errors; whether medication errors should be reported to the patient, family or an outside agency; and, medication administration technology for reducing medication errors. A survey was mailed to a random sample of 800 registered nurses (RN) from across the United States who were members of the American Nurses Association. A response rate of 49% was achieved using a three-wave mailing. The primary causes of medication errors identified were interruptions during medication pass, short RN staffing, nurses caring for high acuity patients, nurses working more than 12 hours in one shift, and nurses' knowledge of medications dispensed. Approximately one-fourth of nurses reported they had made at least one error that had resulted in some type of harm to a patient in the past 12 months, while approximately 60% of nurses reported making one or more medication errors that did not cause harm to a patient. Rank ordering identified three major barriers to reporting medication errors: fear of

consequences that may result if a medication error is reported, fear of blame if something happens to the patient due to a medication error, and fear of a reprimand if they reported a medication error had been made. Nurses perceived that medication administration technologies would decrease medication errors in their hospital. The majority of nurses overwhelmingly agreed that medication errors should be communicated to patients or families, as well as hospitals being responsible for communicating their error rates to the public. Results of this study have serious implications for individual staff nurses, nurse administrators, as well as hospital administration and hospital systems in terms of error reduction and patient safety.

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## **Chapter 1**

### **Introduction**

The medication administration process is an everyday part of nursing practice (Gibson, 2001), and is so much more than a simple psychomotor task (Wakefield, Wakefield, Uden-Holman, & Blegan, 1998). Although nurses have the central role in this process, it involves a multidisciplinary team that also consists of the physician, pharmacist, and patient. In the acute care setting of a hospital the medication process is complex and time-consuming, occupying up to one-third of the nurses time (Pepper, 1995). Medication administration is often carried out under chaotic and stressful circumstances and is probably the highest risk activity a nurse performs. An error in the medication process can be minor or lead to devastating effects for the patient and also for the nurses' career (Anderson & Webster, 2001). This chapter will provide an overview of the nurses' role in the medication administration process. The chapter consists of the Statement of the Problem, Significance of the Problem, Research Questions and Hypotheses, Definition of Terms, Delimitations of the Study, and Limitations of the Study.

## **1.1 Statement of the Problem**

Patient safety has had national attention since the 2000 Institute of Medicine (IOM) report entitled, *To Err Is Human: Building a Safer Health System*. In this report errors in health care were found to be a leading cause of death ( $n = 98,000$ ) and injury. Prior to this report in 1993, medication errors were estimated to have accounted for only 7,000 patient deaths per year (Phillips, Christianfield, & Glynn 1998). Though more current research is available on medication errors, a historical review of medication error literature prior to the year 2000 has been included in this paper due to the vast national safety changes that resulted from the 2000 IOM report. A 1997 analysis by Lesar, Briceland, and Stein of nearly 300,000 medication prescriptions written during one year in a teaching hospital, the overall error rate was estimated to be 3.13 errors per 1,000 prescriptions, with the rate of significant errors to be 1.81 per 1000 prescriptions. In a 1995 study by Bates et al. over 4,000 adult admissions to 11 medical and surgical units were reviewed at two teaching hospitals. The researchers identified 247 adverse drug events (ADE) for an event rate of 6.5 ADEs per 100 nonobstetrical admissions, with a mean number per hospital/year of 1,900 ADEs. Of these identified ADEs, 28% were identified as preventable. According to Peppers (1995), one out of every three ADEs related to medication errors occurred when a nurse administered medications. The frequency of medication errors has been found to be the highest at patient care transition points. Transition points include: admission to the hospital, transfer from one unit to another, change in the caregiver responsible for a patient, and during discharge to the home or another facility. These errors are most frequently related to incomplete or

inaccurate medical information (Rosich & Resar, 2001). Pronovost et al. (2003) estimated the medication error rate at transition points to be 46% of all errors.

Since it is the nurse who has the responsibility of administering medications to patients, the nurse has often assumed or been assigned blame for these errors. In reality, there is usually a chain of events leading to an error. Medication errors are seldom the result of one person, but involve the actions of everyone caught up in the system, including the designers of the system (Wakefield et al. 1998).

## **1.2 Significance of the Problem**

Errors related to medications occur frequently in hospitals. Though most errors do not result in harm to the patient, the ones that do can be very costly (IOM, 2000). A 1997 study by Bates et al. reviewed admissions at two prestigious teaching hospitals. The researchers found that nearly two percent of patient admissions experienced a preventable ADE. These preventable errors increased hospital costs approximately \$4,700 per admission or nearly \$2.8 million annually for a 700 bed teaching hospital. If these findings are generalizable, preventable ADEs are costing the nation about \$2 billion per year (IOM, 2000). Classen, Pestotnik, Evans, Lloyd, and Burke (1997) also reviewed all admissions to a large teaching hospital from 1990 through 1993. These researchers found that 2.43 admissions per 100 were complicated by an ADE. Additionally, the adverse event increased patient length of stay (LOS) 1.91 days and increased costs by \$2,262 (Classen et al., 1997).

Besides increased hospital costs, preventable adverse events are also responsible for indirect costs, such as lost productivity, disability, and personal costs related to care (IOM, 2000). In a study by Thomas et al. (1999), nearly 15,000 randomly selected

discharges were reviewed from 28 hospitals in Colorado and Utah. A total of 459 adverse events were identified. Of these, 265 were found to be preventable with associated direct and indirect costs of \$308 million. These researchers estimated the annual national costs of preventable adverse events to be \$17 billion. However, the incidence of medication errors is almost certainly too low due to many errors going unreported or undetected (IOM, 2000).

In response to the unacceptably high errors in health care following the IOM report in 2000, the Agency for Healthcare Research and Quality (AHRQ), an agency within the Department of Health and Human Service (DHHS), was congressionally mandated to create a patient safety research and development initiative to assist health care personnel to decrease medical errors and increase patient safety (RAND Health, 2005). Federal funding has been provided to AHRQ to support patient safety research and implementation of safety activities (RAND Health, 2005).

In addition to the AHRQ, the first National Patient Safety Goals (NPSG) were developed by the Sentinel Event Advisory Group of the Joint Commission on Accreditation of Healthcare Organizations (JCAHO, 2006). These goals were developed to help health care organizations improve patient safety by addressing specific safety concerns. The six initial goals took effect January 2003 and were re-evaluated on a yearly basis (Catalano, 2005). Three of the goals were specifically related to increasing medication safety. NPSG 3 related to improving the safety of using medications and in 2006 this specific goal had four components. To be in compliance with these components hospitals needed to: (a) remove concentrated electrolytes (such as potassium chloride) from patient care units (goal retired 2006); (b) standardize and limit the number

of medication concentrations available in the hospital setting; (c) annually identify and review look-alike and sound-alike medications; and. (d) label all medications and medication containers on and off the sterile field in peri-operative and other procedural settings. NPSG 5 also relates to medication safety, focusing on increasing the safety of infusion pumps. Hospitals must now ensure free-flow protection on all general use infusion pumps along with patient-controlled analgesia (retired 2006). Lastly, NPSG 8 of 2006, identified the need to accurately and completely reconcile medications across the continuum of care. Part A called for organizations to implement a process to document an accurate and current listing of patients' medications on admission and compare this list of medications to the medications the organization provides. Part B of this goal asked that a complete list of the patients' medications be communicated to the next provider of care when the patient was either discharged or transferred inside or outside the organization (JCAHO, 2006).

### **1.3 Purpose of the Study**

Though other health care fields, such as physicians and pharmacists, have been involved in extensive research and writing on the safety of the medication administration process, nursing has not (Burke, 2005). In July of 2004, The University of Pennsylvania School of Nursing, the Hospital of the University of Pennsylvania, the Infusion Nurses Society, along with the *American Journal of Nursing* held a symposium on "The State of the Science on Safe Medication Administration." The goals of this meeting were to make clinical education and policy recommendations and to identify research priorities to improve the safety of the medication administration process (Burke, 2005). Forty nursing experts from all areas, such as clinical practice, education, administration and research

were present. Leaders in regulatory, and consumer sectors, along with representatives from the health industry were also at this two day meeting (Burke, 2005). Symposium participants identified gaps in existing research and prioritized areas and direction for future nursing research (See Table 1). Because of the core role of nurses in the medication administration process, they are key links to identifying errors (Pape, 2001). Nurses' knowledge, along with the intimate relationships they establish with their patients (Balas, Scott, & Rogers, 2004), puts them in an excellent position to identify and intercept these potential errors (Leape et al., 1995). According to Pape (2001), there is a need to identify all causes of medication errors by asking nurses what they perceive as the causes of these errors, what they believe constitutes an error because there is inconsistency, and to determine what risk factors contribute most to medication errors. In addition, a literature review on adverse events in drug administration suggested "a large scale, multi-centered survey should be implemented to generate a sample large enough to provide statistically significant findings in terms of contributory factors" (Armitage & Knapman, 2003, p. 138).

**Table 1-1**  
*Priorities for Research on Safe Medication Administration*

Symposium participants suggested questions researchers should ask:
<i>How Do Safety Climate, Error Reporting, And Root Cause Analysis Affect Patient Safety, Quality of Care, And Both Patient And Clinician Satisfaction?</i>
<ul style="list-style-type: none"> <li>• What factors and approaches support creating and maintaining blame-free environments?</li> <li>• What are the best practices for identifying errors?</li> <li>• How do differing definitions of "error" among providers and administrators affect error reporting, root cause analysis, and patient safety?</li> <li>• Can a taxonomy of errors improve error reporting?</li> <li>• What is the relationship between nurse fatigue and error rate?</li> </ul>



- What are the effects of fatigue and extended work hours on clinicians' response to equipment alarms and on error reporting?
- What are the root causes of staff not following safe practices for medication administration?
- Does the dissemination of error reports influence subsequent error reporting and rates?

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*How Can Individuals And Organizations Integrate And Sustain Best Practices To Detect, Reduce Or Eliminate, And Mitigate The Errors That Occur?*

- What teaching strategies are most effective in disseminating standards of practice in nursing schools and practice settings?
- Why aren't nurses full participants on multidisciplinary teams addressing patient safety? How does team participation affect medication errors?
- How do staffing ratios and staff stability (turnover rate) affect error rates?
- Do nurses change their practices when given brief, easy-to-read reports of research into errors and their prevention?
- What are cost-effective ways to manage the dissemination of information, and what are new clinical approaches to reducing medication errors?
- How do 12-hour shifts affect patient safety, both favorably (continuity of care can reduce errors) and adversely (fatigue can increase errors)?
- How can feedback from pharmacists and nurses be used to prevent errors?
- What are effective methods of encouraging patients to ask about the medications they are being given?
- Can errors be reduced by training providers to question and discuss medication orders and dispensing procedures?
- What are effective approaches to changing the practices of physicians, nurses, and other providers in order to foster safer medication administration?
- What is the impact of "work-arounds" (time-saving practices developed by nurses and others), particularly in relation to new technologies designed to improve safety?
- Does standardization of medication administration practices and equipment result in fewer errors?
- Do Magnet hospitals have lower rates of medication errors?
- What tools do nurses need to prevent or mitigate medication errors?
- Do nurses' levels of experience or education correlate with their medication error rates?
- What kinds of errors are associated with "smart" IV pump systems and automated dispensing cabinets?
- What modifications in the work environment and organization best maximize the benefits and minimize the risks of new technologies?

- Can personal digital assistants (PDAs) make medication administration safer by making information available at the point of care?

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*What Patient-Centered Approaches Result In Medication Error Reduction In Ambulatory And Long-Term Care Settings?*

- What technologies can make medication administration safer in these care settings?
- What factors contribute to medication errors in these care settings?
- How are medication errors reported in these care settings, and how is information disseminated?

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*How Do Current Practices And Near Misses Make Medication Administration Safer?*

- What systems, environmental, and individual factors can eliminate or reduce error in acute care settings?
- What are the best practices to reduce interruptions of nurses during medication administration? How do such interruptions affect the frequency and type of medication errors?
- Does nurses' questioning of accuracy and appropriateness of medication orders result in fewer errors? What factors contribute to nurses' questioning or not questioning medication orders?
- To what extent is safety increased by daily or regular monitoring of patients' compliance with medication regimens?
- What are the barriers to standardizing medication dosages, forms, and computerized entry of physicians' orders?
- What are the most common causes of near misses in medication administration?
- What factors in the work environment promote or inhibit nurses' reporting of near misses?

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*What Is The Impact Of Safer Medication Administration Practices On Health Care Costs And Patient Outcomes?*

- How cost effective are various technologies developed to promote safer medication administration with regard to errors, patient compliance, hospitalization, and ED visits?
- How do best practices in medication administration affect costs?
- Does standardization of a reconciliation process across settings make medication administration safer?
- Can bar coding support medication reconciliation?
- What is the impact of educational programs for consumers about their roles in preventing errors?
- What is the financial impact of errors caught or prevented by nurses?

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Adapted from: Burke, K. (2005). Executive summary: The state of the science on safe medication administration symposium. *American Journal of Nursing*, 105(3), 73-79.

Lastly, there have been no published research studies or more current nursing research that could be found demonstrating strong correlations between nurse characteristics and number of medication errors (Blegan, Vaughn, & Good, 2001; Osborne, Blais, & Hayes, 1999).

The purpose of this study was to explore the relationship between nurse characteristics and medication errors. The study also examined nurses' perceptions of factors which contribute to medication errors, along with barriers to reporting medication errors and the factors that increase reporting of medication errors. In addition, the issue of whether medication errors should be reported to the patient, family or an outside agency was explored. Lastly, medication administration technology was examined in terms of reducing medication errors.

## **1.4 Research Questions and Hypotheses**

### **Research Question 1**

Is there a relationship between nurse characteristics and medication errors?

#### **Hypothesis 1.1**

There is no statistically significant difference in the number of self reported medication errors that caused harm to a patient between nurses with national certification in their area of clinical practice and those without national certification.

#### **Hypothesis 1.2**

There is no statistically significant difference in the number of self reported medication errors that "did not harm" a patient between nurses with national certification in their area of clinical practice and those without national certification.

### **Hypothesis 1.3**

There is no statistically significant difference in the number of self reported medication errors by nurses that caused harm to a patient based on their number of years of clinical experience.

### **Hypothesis 1.4**

There is no statistically significant difference in the number of self reported medication errors by nurses that “did not cause harm” to a patient based on their number of years of clinical experience.

### **Hypothesis 1.5**

There is no statistically significant difference in the number of self reported medication errors that caused harm to a patient between nurses who have participated in pharmacology continuing education less than two years ago and those who have not participated in pharmacology continuing education in the past two or more years.

### **Hypothesis 1.6**

There is no statistically significant difference in the number of self reported medication errors that “did not cause harm” to a patient between nurses who have participated in pharmacology continuing education less than two years ago and those who have not participated in pharmacology continuing education in the past two or more years.

### **Hypothesis 1.7**

There is no statistically significant difference in the number of self reported medication errors that caused harm to a patient among nurses with a bachelor’s degree in

nursing and those with less than a bachelor's degree (associate degree and diploma in nursing).

### **Hypothesis 1.8**

There is no statistically significant difference in the number of self reported medication errors that “did not cause harm” to a patient among nurses with a bachelor's degree in nursing and those with less than a bachelor's degree (associate degree and diploma in nursing).

### **Hypothesis 1.9**

There is no statistically significant difference in the number of self reported medication errors that caused harm to a patient between nurses who have taken a formal course in pharmacology and those whose pharmacology was integrated throughout the nursing curriculum in their undergraduate program.

### **Hypothesis 1.10**

There is no statistically significant difference in the number of self reported medication errors that “did not cause harm” to a patient between nurses who have taken a formal course in pharmacology and those whose pharmacology was integrated throughout the nursing curriculum in their undergraduate program.

### **Hypothesis 1.11**

There is no statistically significant difference in the number of self reported medication errors that caused harm to a patient between nurses who work full-time and those who do not work full-time.

### **Hypothesis 1.12**

There is no statistically significant difference in the number of self reported medication errors that “did not cause harm” to a patient between nurses who work full-time and those who do not work full-time.

### **Hypothesis 1.13**

There is no statistically significant difference in the number of self reported medication errors that caused harm to a patient among nurses who work day shift, night shift or rotating shifts.

### **Hypothesis 1.14**

There is no statistically significant difference in the number of self reported medication errors that “did not cause harm” to a patient among nurses who work day shift, night shift or rotating shifts.

### **Hypothesis 1.15**

There is no statistically significant difference in the number of self reported medication errors that caused harm to a patient between nurses who have had their mathematical skills formally tested at work within the past two years compared to those who have not had their mathematical skills formally tested at work within the past two years.

### **Hypothesis 1.16**

There is no statistically significant difference in the number of self reported medication errors that “did not cause harm” to a patient between nurses who have had their mathematical skills formally tested at work within the past two years compared to

those who have not had their mathematical skills formally tested at work within the past two years.

#### **Hypothesis 1.17**

There is no statistically significant difference in the number of self reported medication errors that caused harm to a patient between nurses who consistently work in the same clinical practice setting and those that do not consistently work in the same clinical practice setting.

#### **Hypothesis 1.18**

There is no statistically significant difference in the number of self reported medication errors that “did not harm” a patient between nurses who consistently work in the same clinical practice setting and those that do not consistently work in the same clinical practice setting.

#### **Hypothesis 1.19**

There is no statistically significant difference in the number of self reported medication errors that caused harm to a patient among nurses based on the size of the hospital (e.g. number of beds) where they work.

#### **Hypothesis 1.20**

There is no statistically significant difference in the number of self reported medication errors that “did not cause harm: to a patient among nurses based on the size of the hospital (e.g. number of beds) where they work.

#### **Hypothesis 1.21**

There is no statistically significant difference in the number of self reported medications errors that caused harm to a patient among nurses when they have worked

over twelve hours in one day as compared to those who have not worked over 12 hours in one day.

### **Hypothesis 1.22**

There is no statistically significant difference in the number of self reported medications errors that “did not cause harm” to a patient among nurses when they have worked over twelve hours in one day as compared to those who have not worked over 12 hours in one day.

## **Research Question 2**

What are the factors that nurses perceive as barriers to medication error reporting?

### **Hypothesis 2.1**

There is no statistically significant difference in nurses’ perception of the number of barriers to reporting medication errors based on level of education.

### **Hypothesis 2.2**

There is no statistically significant difference in nurses’ perception of the number of barriers to reporting medication errors based on national certification.

### **Hypothesis 2.3**

There is no statistically significant difference in nurses’ perception of the number of barriers to reporting medication errors based on years of clinical experience.

### **Hypothesis 2.4**

There is no statistically significant difference in nurses’ perception of the number of barriers to reporting medication errors based on the size of hospital where the nurse works.



### **Hypothesis 2.5**

There is no statistically significant difference in nurses' perception of the number of barriers to reporting medication errors based on whether the nurse consistently works in the same clinical setting.

### **Hypothesis 2.6**

There is no statistically significant difference in nurses' perception of the number of barriers to reporting medication errors based on the age of the nurse.

### **Hypothesis 2.7**

There is no statistically significant difference in nurses' perception of the number of barriers to reporting medication errors based on the gender of the nurse.

### **Research Question 3**

What are the factors that nurses perceive as increasing their likelihood of reporting medication errors?

### **Hypothesis 3.1**

There is no statistically significant difference in nurses' perception of the number of factors that would increase their likelihood of reporting medication errors based on level of education.

### **Hypothesis 3.2**

There is no statistically significant difference in nurses' perception of the number of factors that would increase their likelihood of reporting medication errors based on national certification.

### **Hypothesis 3.3**

There is no statistically significant difference in nurses' perception of the number of factors that would increase their likelihood of reporting medication errors based on years of clinical experience.

### **Hypothesis 3.4**

There is no statistically significant difference in nurses' perception of the number of factors that would increase their likelihood of reporting medication errors based on the size of hospital where the nurse works.

### **Hypothesis 3.5**

There is no statistically significant difference in nurses' perception of the number of factors that would increase their likelihood of reporting medication errors based on whether the nurse consistently works in the same practice setting.

### **Hypothesis 3.6**

There is no statistically significant difference in nurses' perception of the number of factors that would increase their likelihood of reporting medication errors based on the age of the nurse.

### **Hypothesis 3.7**

There is no statistically significant difference in nurses' perception of the number of factors that would increase their likelihood of reporting medication errors based on the gender of the nurse.

#### **Research Question 4**

Do nurses support open communication regarding medication errors?

##### **Hypothesis 4.1**

The majority of nurses will support communicating to the patient when a medication error has occurred.

##### **Hypothesis 4.2**

The majority of nurses will support communicating to the family (in appropriate circumstances) when a medication error has occurred.

##### **Hypothesis 4.3**

The majority of nurses will support medical error report cards for hospitals that are reported to governmental agencies, and then published for the public to review.

#### **Research Question 5**

Do nurses perceive the use of medication technology as helpful in reducing medication errors in the acute care setting?

##### **Hypothesis 5.1**

The majority of nurses will perceive barcode medication administration as helpful or very helpful in reducing medication errors within their hospital.

##### **Hypothesis 5.2**

The majority of nurses will perceive computerized physician order entry as helpful or very helpful in reducing medication errors within their hospital.

##### **Hypothesis 5.3**

The majority of nurses will perceive automated medication dispensing as helpful or very helpful in reducing medication errors within their hospital.

#### **Hypothesis 5.4**

The majority of nurses will perceive “smart infusion pumps” as helpful or very helpful in reducing medication errors within their hospital.

#### **1.5 Definition of Terms**

*Adverse drug event* - “noxious and unintended and occurs at doses used in humans for prophylaxis, diagnosis therapy, or modification of physiologic functions” (World Health Organization, in Classen et al., 1997, p. 302).

*Clinical nurse* - “any nurse working in the hospital setting who has completed a three year undergraduate nursing degree” (Manias & Bullock, 2002, p. 775).

*Certification* - “process by which a nongovernmental agency validates, based upon predetermined standards, an individual nurse’s qualification and knowledge for practice in a defined functional or clinical area of nursing” (American Association of Critical Care Nurses [AACN] Certification Corporation, ¶1).

*Failure to rescue* - “the inability of a hospital to ,rescue’ a patient from complications that occur after the patient’s admission to the hospital”. It is calculated by using the total number of complications as the denominator and the number of deaths caused by those complications as the numerator (Silber, Williams, Kakauer, Schwartz, 1992 in Seago, Williamson, & Atwood, 2006).

*Feeling of safety* - no fear of retaliation (Pape, 2001), positive response for reporting medication errors (Stratton, Blegen, Pepper, & Vaughn, 2004), no blame (Hughes & Ortiz, 2005).

*Graduate nurse* - “a nurse in the first year of clinical practice following completion of a three year undergraduate degree in the United Kingdom” (Manias & Bullock, 2002, p. 775).

*Hospital size* - determined by inpatient hospital beds, less than 100 beds (small), 100–299 beds (medium), greater than 300 beds (large).

*Intra-professional* – the relationship between a staff nurse and nursing administration.

*Inter-professional* – the relationship between a staff nurse and the physicians with whom the nurse works.

*Majority* - a number greater than half of the total (Merriam Webster’s, 1995).

*Medication error* - any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the healthcare profession, patient, or consumer. Such events may be related to professional practice, health care products, procedures, and systems, including prescribing; order communication; product labeling, packaging, and nomenclature; compounding; dispensing; distribution; administration; education; monitoring; and use (USP Quality Review, 1997).

*Near miss* - an event or situation that could have resulted in an accident, illness, or injury but did not, either by chance or timely intervention (Miller, 2004 in Berntsen, 2004).

## **1.6 Delimitations**

This study had several delimitations. The main delimitations were:

- Survey instrument is self- reported, participants may respond in a socially desirable manner versus honestly.
- Selection of a closed format survey does not allow researcher to elicit any additional information from nurse respondents.
- Includes only nurses who are members of the American Nurses Association (ANA) in the United States.
- Includes only nurses who work in the acute care setting.
- Includes only nurses who can read and understand English.

## **1.7 Limitations**

This study has the following potential limitations:

- The monothematic nature of survey may have caused a response bias in some participants.
- The further the return rate is from 100% the greater the threat to the external validity of the results. The current survey had a 49% return rate, a potentially serious threat to generalizability of the findings.
- A problem with all surveys is that of self reported data. The extent of socially desirable responses to some questions by some nurses is unknown. However, to help minimize this issue, the cover letters assured respondents that their answers would be kept confidential.
- Finally, the cross-sectional nature of surveys precludes drawing any cause and effect between dependent and independent variables.

## **Chapter 2**

### **Review of Literature**

This chapter discusses the nurses' role in the medication administration process. Specifically, this chapter examines the following issues: Definition and Categories of Medication Errors, Nurses' Perceptions of Medication Errors, Factors Contributing to Medication Errors, Safety Systems Associated with Medication Administration, Reporting of Errors, Injury Prevention Model, and Summary.

### **2.1 Definitions and Categories of Medication Errors**

#### **2.1.1 Definitions**

A review of the literature demonstrates that there is not one standard definition for what constitutes a medication error, but that the definition has varied across the literature (Armitage & Knapman, 2003; O'Shea, 1999). An early, but commonly used definition was that by Barker and McConnell (1962):

The administration of the wrong medication, drug, diagnostic agent, chemical or treatment requiring the use of such agents, to the wrong patient or at the wrong time or failure to administer such agents at the specified time or in the manner prescribed or normally considered as accepted practice (p.361).

A problem associated with the aforementioned definition is its lack of any reference to a possible error in the writing of the original prescription.

Allen and Barker (1990), along with Cooper (1995) and Mayo and Duncan (2004) all defined a medication error similarly, based on the American Society of Hospital Pharmacists (ASHP) standard definition of a medication error. “A dose of medication that deviates from the physician’s medication order on the patients chart” (ASHP, 1982, p.321). Unfortunately, this definition also lacks reference to prescribing errors. Wolf (1989) described a more inclusive definition of medication errors. Medication errors are “mistakes associated with drugs and IV solutions that are made during the prescription, transcription, dispensing, and administration phases of drug preparation and distribution” (p. 8).

Lastly, in 1997 the National Coordinating Council for Medication Error Reporting and Prevention presented a standard definition of a medication error as follows:

A medication error is any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the healthcare profession, patient, or consumer. Such events may be related to professional practice, health care products, procedures, and systems, including prescribing; order communication; product labeling, packaging, and nomenclature; compounding; dispensing; distribution; administration; education; monitoring; and use (USP Quality Review, 1997, ¶1).

For the current study the aforementioned definition will be used for the term medication error, as it has a multidisciplinary perspective. Additionally, most other definitions are embedded within this description of the term medication error.



### **2.1.2 Categories of Medication Errors**

Along with the definition of medication errors, categories of medication errors also vary across the literature. The ASHP (1982) have identified nine categories of medication errors. These include:

1. Omission error- failure to administer an ordered dose unless refused by patient or because of recognized contraindications.
2. Unauthorized drug error- administering an unauthorized medication dose to the patient (e.g., duplicate dose, wrong patient, unordered medication).
3. Wrong dose error- any dose above or below the ordered dose.
4. Wrong route error- administering a medication by a route not ordered by the physician (e.g., intravenous versus oral), or medication given at the wrong site (right ear versus left).
5. Wrong rate error- administering a medication at the wrong rate as stated in the physician order or hospital policy.
6. Wrong dosage form error- administering a medication in a different dosage form than ordered (e.g., ointment versus solution).
7. Wrong time error- administering a medication a certain amount of time before or after it is scheduled, with that amount of time being set by hospital policy.
8. Wrong preparation of a dose- inaccurate preparation of a medication (e.g., incorrect dilution or incorrect mixing of a medication).
9. Incorrect administration technique- use of improper technique (e.g., incorrect use of an administration device such as an inhaler or not using a specific injection technique when indicated, such as Z track method).

In 1990, while examining error rates in an Iowa hospital, Scholz adapted the ASHP categories of medication errors to include a tenth category, failure to follow specific unit protocols (e.g. nitroglycerin drip).

According to Wolf (1989), medication errors can be categorized as two basic types: errors of commission and errors of omission. Wolf then further divided both categories into intentional and unintentional errors. This system of categorization does appear to incorporate the ASHP nine category system. Interestingly, the idea of prescriber error is not addressed in any of the aforementioned categories.

In summary, there are a variety of definitions and categories of medication errors that have been utilized in the literature with only minor adjustments over the years. Currently, the definitions and categories are beginning to be reviewed in a more multidisciplinary perspective.

### **2.1.3 Nurses' Perceptions of Medication Errors**

Because nurses play a key role in the process of medication administration, namely administering the medication to the patient, it is important to understand nurses' perceptions of what constitutes an error and why errors occur. A comprehensive review of the literature found seven articles on nurses' perceptions of medication errors. Two of the studies focused on what constitutes or qualifies as a medication error (Balas, Scott, & Rogers, 2004; Hackel, Butt, & Banister, 1996). Five of the studies focused on the underlying factors contributing to medication errors (Gladstone, 1995; Mayo & Duncan, 2004; Osborne, Blais, & Hayes 1999; Ulanimo, O'Leary-Kelley, & Connolly, 2007; Wakefield et al., 1998).

In the study by Hackel, Butt, and Banister (1996), a major aim of the researchers was to identify what constitutes a medication error. This study was carried out in an urban community hospital with registered and practical nurses. Out of a population of 400 nurses, 146 surveys were returned for a response rate of 36.5%. As part of the study, participants were asked to select what they considered to be medication errors. The ten items included in the tool were all considered to be medication errors taken from a review of current nursing textbooks. The findings indicated that the nurses viewed medication errors differently from the current literature. The majority of nurses surveyed agreed that wrong medication (97%), wrong time (78%), wrong patient (97%), wrong dose (97%), wrong route (94%), and erroneous omission (88%) constituted medication errors, while a much lower percentage of the same nurses identified assessment of needs (23%), effect not documented (30%), omission not documented (47%), and teaching not documented (27%) as medication errors. The study also identified that the hospital did not have guidelines specifying what constitutes a medication error.

The purpose of the study by Balas, Scott, and Rogers (2004) was to describe the nature and prevalence of all errors (procedural, transcription, charting, failure to prevent injury, and medication) and near errors reported by hospital nurses. The findings were from a large, random national study of American Nurses Association (ANA) nurses examining the relationship between staff nurse fatigue and patient safety. A random sample of hospital staff nurses was obtained from the ANA membership list. A total of 393 nurses completed the study, for a response rate of 40%. Participants kept logbooks for a two week period and were asked to complete a maximum of 40 questions per day when working, and 17 questions on non-work days. On work days, nurse participants

were asked, “Did you make any medication or other errors today?” and “Did you catch yourself before you were about to make an error today?” If nurses responded yes to these questions, they were asked to describe the incident. Results showed 58% of nurses made medication related errors and 59% of nurses made near errors that were medication related over the two week period. Approximately 34% of the actual errors were due to late administration, because of high patient acuity and heavy workloads. Other errors included 24% due to a wrong dose, 17% wrong medication, 16% due to omission of a medication, 8% to the wrong patient, and 2% by the wrong medication route. Nurses described frequent interruptions and distractions while preparing medications, as well as lack of communication between health care providers as contributing factors in making a medication error. Additionally, Balas et al. (2004) determined this study showed that nurses would report errors when they felt safe, when the reporting system was not cumbersome, and the nurses’ identity was kept confidential.

The aim of the 1995 study by Gladstone was to identify common themes contributing to the occurrence and reporting of medication errors in a district general hospital in England. The study was carried out over a 12 month period with data collected from four sources. The sources included drug incident forms, informal interviews with any nurse who had made a drug error, self-administered questionnaires to nurses who regularly administered medications, and nurse managers who were likely to deal with nurses who had made medication errors. In total, 79 incident reports were reviewed. A stratified sample of 102 nurses was selected for the study, with 81 surveys returned for a response rate of 79%. A different questionnaire was completed by 17 nurse managers and 14 nurses who had made a medication error volunteered to be

interviewed. A review of the incident reports showed that over 50% of the medication errors were dose related: 18% were incorrect infusion rates of intravenous fluid (IV), 17% were non-prescribed/extra dose, 11% were incorrect doses, and 6% were omitted doses. Questionnaire participants were asked to rank ten statements about the causes of medication errors in order of perceived frequency. The four highest ranked statements by the nurses included:

1. Drug errors occur when the nurse fails to check the patient's name band with the prescription chart.
2. Drug errors occur when the doctor's writing on the prescription chart is difficult to read or illegible.
3. Drug errors occur when nurses are distracted by other patients/events on the ward.
4. Drug errors occur when a nurse miscalculates the dose.

The nurse managers also ranked the first three statements as having high importance. The managers differed from the nurses on their fourth ranked statement. The fourth ranked statement by nurse managers concerned errors being made when the nurse sets up or adjusts an infusion device incorrectly. The nurses were also asked to evaluate four scenarios to decide whether or not a medication error had been made. Findings showed that 63% of the nurses were not sure as to what constituted a medication error or when errors should be reported. Due to fear of management reaction, 74% of the nurses identified they did not report medication errors. Interviews with the nurses who had made an error identified factors they thought contributed to the mistake. The four

most frequently identified factors included: workload, poor skill mix, interruptions, and loss of concentration.

Osborne, Blais and Hayes (1999), utilized the survey designed by Gladstone with modifications. The target population was a group of medical-surgical nurses working in a 700 bed hospital in southern Florida. Out of the 92 surveys distributed, 57 were returned for a response rate of 62%. In this survey, 35% of the nurses responded that the major cause of medication errors was due to failure to identify the patient's name-band with the medication administration record (MAR). Twenty-five percent identified that errors occur when nurses are tired and exhausted. Both of these statements were also ranked high in Gladstone's (1995) original questionnaire. In this study, 84% of the nurses felt they were usually sure of what constitutes a medication error as compared to 63% in Gladstone's (1995) study. In addition, 86% reported they knew when an incident report (IR) should be completed, 84% felt medication errors were not reported because nurses were afraid, and 58% did not report medication errors if they did not consider the mistake to be serious. Lastly, 25% identified they had failed to report a medication error because they were afraid of repercussions (Osborne et al., 1999).

In 2004, Mayo and Duncan published their study on nurses' perceptions of medication errors using the modified Gladstone questionnaire. The target population for this study was 9,000 acute care registered nurses (RNs) working in both medical-surgical and specialty units, practicing in 16 Southern California hospitals. Surveys were sent to a random sample of these RNs. A total of 985 RNs responded to the survey for a 20% return rate. The highest ranked factors underlying medication errors were:

1. Physicians' writing is difficult to read.

2. Nurses are distracted by patients, coworkers or events.
3. Nurses are tired and exhausted.

In this survey, six different scenarios could be classified as medication errors, using a yes or no response. Some of the scenarios elicited common responses in terms of classification, though other scenarios had quite different responses. For example, the researchers identified that most nurses (97%) would classify a fast running total parenteral nutrition rate (200mL/h for 3 hours instead of the correct 125mL/h) as a medication error, but most nurses (92%) would not classify withholding a scheduled morning dose of digoxin because the blood level report was late. In contrast, nurses were split (yes at 56% versus no at 45%) when classifying a scenario of a missed scheduled medication while a patient was sleeping. Though the nurses in this study were not in high agreement about what defines a medication error, 93% felt they were usually sure what constituted an error and when to report an error (91%). In addition to evaluating scenarios, nurses were asked their perception of the percentage of medication errors reported to the nurse manager using a written IR. Less than half of the nurses (46%) believed that all medication errors were reported in this manner. Key reasons for not reporting errors included: afraid of managers' reactions (77%), afraid of co-workers reactions (61%), and not thinking an error was serious enough (53%). Most of the nurses (80%) did not fear losing their job due to an error (Mayo & Duncan, 2004).

In 1998, Wakefield, Wakefield, Uden-Holman and Blegan published a study on nurses' perceptions of why medication errors occur. They utilized a nonrandom convenience sample of nurses from 24 of Iowa's acute care hospitals. A total of 1,384 nurses responded to the survey, though a total response rate was not included in the

article. The instrument consisted of 18 statements reflecting reasons why medication errors occur. Nurses were asked to respond using a Likert-type scale with values of one (strongly disagree) to six (strongly agree). Analysis of individual statements of reasons why medication errors occur demonstrated highest mean values for being interrupted while administering medications and doctor's orders not legible. The study also found that nurse managers were more likely than staff nurses to perceive individual factors as reasons for medication errors, ranking it second highest in importance as compared to staff nurses who ranked it fourth highest in importance (Wakefield et al., 1998).

Lastly, a recent study by Ulanimo, O'Leary-Kelley, and Connolly (2007) looked at nurses' perceptions of causes of medication errors and barriers to reporting with information technology systems in place. The researchers utilized a convenience sample of 61 RNs working medical-surgical units in Northern California. These nurses routinely administered medications utilizing electronic physician orders (POE), bar-coded medication administration (BCMA), and a computerized patient record system. The researchers utilized a modified Gladstone questionnaire adapted with permission. From the total surveys, 25 surveys were usable for a return rate of 44%. In this study, the researchers identified the number one cause of medication errors to be when the nurse failed to check the patient's name-band with the medication administration record (46%). The second most frequently perceived cause of errors was when the nurse was tired and exhausted (33%). These findings are similar to Osborne et al. (1999). In addition, nurses believed only 29% of all medication errors are reported to nurse managers using a written incident report. This response was lower than the 46% reported by Mayo and Duncan (2004), which was already a cause for concern. This study found that 92% of nurses were



usually sure what constituted a medication error, with 88% fairly sure when the error should be reported. The qualitative portion of this study identified barriers to reporting that included: lack of policies, procedures, and unit routines; busy unit; nurses' negligence; along with the nurses' attitude and personality. Empowerments to reporting included: understanding and supportive supervisors and physicians, involvement of nurses and clinical nurse specialists in determining medication errors, having enough time to report, and having a manager who follows through on disciplinary action when a nurse is frequently making errors. Since POE and BCMA were implemented, 80% of nurses felt that they had not made any medication errors, with 12% of nurses remembering making only one error since implementation of these technology systems. All nurses agreed medication errors had decreased since the implementation of POE and BCMA (Ulanimo et al., 2007).

While research has been done on the topic of nurses' perceptions of medication errors, numerous methodological issues have been identified through this review (See Table 2). Specific issues include convenience samples, small sample size, lack of representativeness of samples, lack of reliability testing of surveys, low survey return rates, and lack of conceptual/theoretical framework for the studies. Another important issue regarding this research relates to the currency of the research. Four of the seven studies on medication administration errors were published from 1995 through 1999. Since the year 2000 when the IOM report was issued, many changes have or are currently taking place in the health care arena, specifically in the acute care setting to make patient care safer. The National Patient Safety Goals are now in place, with several of the goals dealing specifically with safer medication administration practices. In addition, the use

of technology, such as computer assisted order entry, bar-coding of medications, computerized robotics, and smart pump infusion technology has begun to alter the way medication administration is being performed on the nursing units and at the patient bedside by nurses. These changes, thought to be positive, could potentially bring along a whole new set of problems related to the medication administration process.

**Table 2-2**

*Methodological Problems in Nursing Research on Medication Errors*

Authors	Sample/Return Rate	Population	Instrument	Validity	Reliability	Theory
Balas, Scott & Rogers (2004)	Random sample 393 out of 4,320 response rate 40%	Full-time hospital staff RN's members of the American Nurses Association	Logbooks kept over 14 days, 40 questions on workdays, 17 nonwork days	Pilot tested	Written logbooks demonstrated reliability during past decade with success, logbook analysis - interrater reliability	Not addressed
Gladstone (1999)	15% stratified sample from population of 675 , utilized random tables, total of 103, response rate 79%	Full and part-time nurses from 1 hospital, south west England	Reviewed 79 incident forms, 2 questionnaires designed by author, one for staff nurses, one for managers, and interviews with nurses who made error	Questionnaire to staff piloted by 5 randomly selected nurses, Questionnaire to managers piloted by 3 senior nurses	Not reported	Not addressed
Hackel, Butt & Banister (1996)	146 returned out of 400, response rate 36.5%	RNs and LPNs from 1 hospital	Questionnaire	Questionnaire critiqued by committee members, graduate nursing students, staff nurses, piloted for reading comprehension, time	Not reported	Multiple Causation Phenomenon
Mayo & Duncan (2004)	983 out of 5,000, response rate 20%	RNs from 16 Southern California hospitals	Survey (modified Gladstone)	Determined acceptable by previous investigators	Reliability established previously, test-retest (.78)	Not addressed
Osborne, Blais & Hayes (1999)	57 out of 92, response rate 61.9 %	Full and part-time RNs in 1 hospital south Florida	Survey (modified Gladstone)	Content validity by 14 professional health care personnel	Test-retest (.78)	Not addressed

Ulanimo, O'Leary-Kelley & Connolly (2007)	25 out of 61, return rate 44%	RNs and LVNs, 1 medical center, northern California	Survey (modified Gladstone)	Determined by previous researchers	Test-re-test (.78)	Not addressed
Wakefield, Wakefield, Uden-Holman & Blegan (1996)	1,384, response rate not reported	RNs and LPNs from 24 Iowa hospitals	Survey	Developed from literature, reviewed by nurses, revised, pilot tested on several units	Not reported	Not addressed

## 2.2 Contributing Factors to Medication Errors

### 2.2.1 Overview

A 1999 literature review by O'Shea identified ten factors contributing to medication errors: mathematical skills of nurses, knowledge of medications, length of nursing experience, length of nursing shifts, workload and staffing levels, nursing care and medication delivery systems, single nurse drug administration, adherence to policies and procedures, distractions and interruptions, and quality of prescriptions (O'Shea, 1999). In addition to the above literature review, a 2003 review by Armitage and Knapman utilized O'Shea's framework to expand upon and re-analyze contributory factors in drug errors. Upon re-evaluation of the review, these two authors found that some of the studies had clear methodological issues. The review authors also found it extremely difficult to identify a clear picture of causation, identifying many variables and confounding factors, along with finding low levels of error reporting (Armitage & Knapman, 2003).

An additional six articles were found dealing with factors contributing to medication errors. Two were review articles (Fry & Dacey, 2007a; Pape, 2001), while the other four were research articles (Fry & Dacey, 2007b; Sanghera, Franklin, & Dhillon, 2007; Seki & Yamazaki 2006; Tang et al., 2007). All four of the research studies found were carried out in countries outside of the United States.

In Pape's (2001) review, the most frequently occurring factors contributing to medications errors included: a lack of knowledge or application of knowledge; use of the wrong drug name, dosage form, or misinterpretation of an abbreviation; and incorrect calculations or unit expressions (e.g. failing to place a zero before a decimal point or placing an unnecessary decimal point following a zero). A summary of the most commonly identified contributing factors to medication errors found in Pape's (2001) literature review are summarized in Table 3. Other contributing factors identified in the review by Fry and Dacey (2007a) that have not consistently been reported included slow pharmacy delivery and disease status of patients.

**Table 3-2**

*Summary of Causes to Medication Administration Errors*

- 
1. Lack of information or knowledge.
  2. Incorrect calculations or unit expressions.
  3. Environmental stress including interruptions, overwork, and fatigue. Slips and memory lapses.
  4. Transcription errors.
  5. Not following protocol including seven rights. Not teaching patients about medications.
  6. Miscommunication including legibility.
  7. Dispensing errors and drug stocking policies.
  8. Problems with labeling, packaging and drug names.
  9. Lack of information about the patient.
  10. Giving drug to patients with known allergy.
  11. Failure to document previous dose.
  12. Infusion pump and IV delivery problems.
  13. Not identifying and resolving error trends.
- 

Adapted from Pape, T., (2001). Searching for the final answer: Factors contributing to medication administration errors. *Journal of Continuing Education in Nursing*, 32(4), 152-160.

The research study conducted by Fry and Dacey (2007b) in the United Kingdom, found that the main contributing factors to medication errors were interruptions by patients, relatives, visitors, and telephone calls which influenced concentration during the process of medication administration. Relevant hindering factors included illegible medication charts, incomplete prescriptions and medications that were not available.

Sanghera, Franklin, and Dhillon (2007) looked at the attitudes and beliefs of healthcare professionals on the causes and reporting of medication errors in a United Kingdom intensive care unit. Interviews were conducted with 13 professionals (prescribers and nurses) involved in 12 medication errors identified by pharmacy. These professionals frequently cited more than one factor as contributing to the error. Important contributing factors to the errors included poor communication and frequent interruptions. They also identified a lack of clarity on the second nurse's check for certain medications and a common practice of administering medications without a complete order. Lack of feedback to staff about previous medication errors was also cited as a contributing factor.

A 2007 study from Taiwan by Tang, Sheu, Yu, Lan, and Chen found that the majority of nurses identified more than one factor contributed to medication errors. The most important factors identified included: personal neglect (e.g. solving other problems while administering medications, heavy workload, and new staff, such as a new graduate or change in ward). Researchers Seki and Yamazaki (2006) looked at the effects of working conditions on „near miss’ intravenous medication errors in a Japanese hospital. The number of near miss errors per 525 person-days was approximately 18% (19 errors), with no significant difference in the number of near miss errors found between shifts.

Reporting of near miss errors increased significantly on the day shift, when nursing care was delayed longer due to workload. On the night shift, frequency of report increased with increased workload and less experience of the nurse on the current ward. In addition, nurses who perceived a lower level of fatigue before work on the day shift and those who had more experience as a nurse and longer sleep on the evening shift experienced a significantly higher near miss frequency than other nurses. Possibly lack of fatigue and longer work experience may help with the identification of errors before they occur (Seki & Yamazaki, 2006).

In the following sections, the review of the literature will be organized around O'Shea's original 1999 review and Armitage and Knapman's 2003 expansion on O'Shea's review, followed by a discussion of other and more recent research findings for each contributing factor.

### **2.2.2 Mathematical Skills of Nurses**

Basic math skills are a prerequisite to performing various nursing interventions, such as medication administration, regulation of intravenous therapy, calculating intake and output, along with conversion of temperature and weight scales (Bayne & Bindler, 1988). Though all nursing programs teach students how to perform mathematical calculations in regards to medication administration, it is possible to incorrectly answer such questions on a test or in a lab setting and still pass the course where the content has been taught (Bayne & Bindler, 1988). Although technological advancements within the hospital system, such as with unit dose, automated dispensing, bar coding, and computerized infusion systems, have decreased the chance of drug calculation error,

these systems have not entirely eliminated errors. In fact, nurses now have less opportunity to calculate medications, possibly losing this skill.

O'Shea (1999) and Armitage and Knapman (2003) discuss the poorly developed medication calculation skills among nurses, citing eight studies between the years of 1984 and 2003 (Bayne & Bindler, 1988; Bindler & Bayne, 1984, 1991; Blais & Bath, 1992; Calliari, 1995; Cheng et al., 1988; Segatore et al., 1993; Worrell & Hodson, 1989). Blais and Bath (1992), along with Segatore et al. (1993), found three major areas of mathematical deficiency among nurses, which included: (a) arithmetic errors of addition, subtraction, multiplication, division, and use of decimals and fractions; (b) conceptual errors, such as difficulty in setting up the problem; and, (c) measurement skills, such as metric and apothecary. Conceptual errors were identified as the most frequent type of deficiency.

Research on the relationship between performance of RNs on mathematics tests and medication errors had been done with conflicting results. Conti and Beare (1988) assessed the performance of nurses on drug calculation tests and subsequent errors, concluding that tests cannot be used as a reliable tool to screen for those nurses most likely to make a medication error. Although, research by Calliari (1995) showed that nurses who made medication errors were more likely to have failed a medication test. Research by Ludwig-Beymer et al. (1990) backed the findings of Conti and Beare (1988), suggesting that the absence of a medication test did not significantly change reported medication error rates. These researchers concluded a written test assessed the ability to pass the test versus assessing the ability of the nurses in a real world scenario.

Since 2003, four nursing research articles on arithmetic skills of nurses have been identified (Glaister, 2005; Greenfield, Whelan, & Cohn, 2006; Jukes & Gilchrist, 2006; Wright, 2004). The study by Jukes and Gilchrist (2006) looked at the calculation abilities of 37 second-year nursing students. On a 10-item test, which included division, multiplication, percentages, ratio and proportion, conversion of units, and multiple-stage procedures, the mean correct score was 6 out of 10, with only three students able to achieve 90% mastery, thus supporting past literature results. Greenfield, Whelan, and Cohn (2006) utilized a quasi-experimental, non-randomized pilot study to look at the use of dimensional analysis as a strategy to reduce nurse medication calculation errors. Dimensional analysis is a medication calculation method in which the units on the medication package are systematically converted to the units of the drug ordered. This method conceptualizes the principles of problem solving, along with supporting critical thinking, while providing nurses one simple method for solving all medication calculation problems. The five steps include:

1. Identify the given quantity.
2. Identify the desired quantity.
3. Establish the unit path for the given quantity to the desired quantity.
4. Set up the problem to allow for cancellation of undesired units.
5. Multiply the numerators and denominators, then divide the product of the numerator by the product of the denominators to obtain the numerical value of the desired quantity (Craig, 2001).

In the study by Greenfield et al. (2006), nursing students were assigned to either a control ( $n = 26$ ) or experimental group ( $n = 39$ ). Students were taught over a one-



semester period following the same course syllabus and with the same instructor. The control students were taught mathematical computation using the traditional formula method, while the experimental group was taught using the dimensional analysis method. At the end of the course, both groups of students took a 25 question examination requiring students to convert units and calculate dosages. Calculators were permitted and students had 50 minutes to complete the examination. Results showed the control group's scores on the medication calculation examinations ranged from 46 to 100 (mean = 86.92). The pass rate was set at 90% with 16 of 26 (61.5%) passing. The experimental group's scores ranged from 75 to 100 (mean = 92.12) with 33 of the 39 (84.6%) students passing. Significantly, more of the experimental group scored with greater accuracy on the examination versus the traditional control group.

In 2004, Wright identified that nursing students have different learning styles and needs, but student nurses were able to integrate the essential mathematical skills into their nursing practice by having different strategies that allowed them to develop their conceptual, mathematical, and practical skills in tandem, while increasing their confidence. The most consistently useful strategies identified were a drug calculation workbook and a two-hour lecture. Other strategies utilized were online learning sessions and practice sessions in the skills laboratory with actual equipment (intravenous infusions, syringes, ampules). Students identified the least useful strategies as the initial questionnaire identifying their weaknesses at the beginning of the course and private study (Wright, 2004).

Glaister (2005) examined three instructional approaches on the learning and transfer of medication calculation competency. The three approaches tested included

integrative learning, computerized learning, and a combination of both integrative and computerized learning. The integrative approach consisted of two one-hour tutorials in which information in the study modules was reinforced along with providing additional worksheets for practice. Computerized learning provided a program on medication calculations for practice with immediate informative feedback. Computerized and integrative learning provided access to all of the learning strategies. In addition, all of the students were required to complete study modules related to medication calculations prior to exposure to one of the three approaches. Results showed that there were no significant differences between the three approaches on knowledge acquisition and knowledge transfer, though computerized learning was found to be significantly more effective in developing procedural knowledge (i.e. knowing how). Three interesting themes were identified from the data analysis of three focus groups. First, self-efficacy appeared to influence performance. Participants that expressed a lowered self-efficacy regarding their mathematical abilities did perform poorly. Second, focus group participants considered the integrative teaching approach more useful as it appeared to influence the perceptions of their ability to calculate dosages due to modeling strategies. Lastly, the participants felt there were very few opportunities in the clinical area to calculate dosages due to unit dosing and the availability of pharmacists, possibly making participants feel the content itself was irrelevant.

In summary, mathematical calculation is a skill nurses must be able to perform accurately to administer medications safely. The ability of nurses to calculate dosages correctly has been a concern for a long period of time and continues to be of concern.

### **2.2.3 Knowledge of Medications**

A review of the literature on nurses' overall knowledge of medications demonstrated a lack of nursing research on this topic. Only four research articles were identified, with all of the research being done outside of the United States (Bullock & Manias, 2002; Manias & Bullock, 2002; King, 2004; Morrow-Frost, 2006). The review did reveal some research related to specific drug groups (e.g. psychotropic medications, certain groups of heart medications) and individual medications (e.g. heparin) that had been carried out in the U.S., though this specific information was not the focus of this paper.

Nurses are responsible for all of the medications they administer and therefore need a working knowledge of the drug classification, physiological action, parameters to be checked prior to administration (e.g. blood pressure, heart rate, respiratory rate), dosage, and pertinent side-effects (O'Shea, 1999). With the number of new medications currently on the market, no nurse can be knowledgeable of all drugs. But he or she should have the resources available to look up those medications that they are not familiar with prior to administration. In addition, it is certainly a nurse's individual responsibility to keep their knowledge of medications up to date.

King (2004) looked specifically at nurses' perceptions of their pharmacology educational needs. She utilized a qualitative approach with a purposive sample of ten nurses from an emergency admissions unit in the United Kingdom. King (2004) found that nurses identified the need for pharmacology knowledge in their clinical practice for accurate medication administration, patient assessment, patient education, and for some nurses prescribing; however, their understanding of pharmacology was limited. The

researcher also found nurses were unhappy with the way pharmacology was taught, with nine out of ten participants feeling their basic nursing program did not spend enough time on pharmacology education. The findings also suggest that there is a theory-practice gap causing a number of identified anxieties related to insufficient preparation (King, 2004), which upholds the understanding found in a previous 1994 study by Jordan.

To identify if undergraduate nursing students were adequately prepared in pharmacology, Manias and Bullock (2002) researched clinical nurses' perceptions along with the experiences of graduate nurses' pharmacology knowledge in two regional hospitals in Australia using focus group interviews. Their findings were similar to King's (2004) study. All participants identified pharmacology to be important to clinical practice. Graduate nurses identified a lack of depth in their own pharmacology knowledge, while clinical nurses identified a great deficit in the graduate nurses' pharmacology knowledge and, in general, identified that most nurses have difficulty understanding and using pharmacology principles in practice. In addition, they identified that undergraduate nursing students needed to take greater responsibility for their pharmacology education, be self-directed, seek out learning experiences, and be a life-long learner, while nursing programs needed to offer increased structured learning experiences related to pharmacology in the practice setting. Lastly, participants identified that structured continuing education on pharmacology for graduate nurses would be helpful to their development in this area (Manias & Bullock, 2002).

Bullock and Manias (2002) also surveyed pharmacology lecturers regarding their perceptions and experiences with undergraduate nursing students' pharmacology preparation from 12 Australian university campuses. Likewise, these participants were

unhappy with the preparation and knowledge base of the graduates. In addition, there was much discrepancy in the numbers of hours each institution devoted to pharmacology and where in the curriculum it was offered, which caused considerable variability in what student nurses experience in their undergraduate pharmacology education (Bullock & Manias, 2002).

A clinical audit by Morrow-Frost (2006) was conducted in a busy admissions and emergency (A & E) department in the United Kingdom. This audit looked at nurses' knowledge of commonly used drugs prescribed in the A & E department. The data were gathered using a multiple choice questionnaire developed by a group of knowledgeable professionals. The results of the audit showed a connection between nurses' grades and their level of pharmacology knowledge (e.g. grade nurses knew more than grade Ds, grades Fs and Es fell in sequence between them). More experienced nurses had greater knowledge than less experienced nurses. A connection was also found between a nurses' grade and their ability to admit a deficiency (e.g. grade Ds were more willing than grade Gs to mark the "don't know" box on the questionnaire). Less experienced nurses were more willing to admit they did not know an answer (Morrow-Frost, 2006).

In summary, there appears to be a research gap in the area of nurses' overall knowledge of medications, especially in the U.S. Though nurses were aware pharmacology knowledge was important to their clinical practice, the available research demonstrates that this knowledge was limited. Lastly, it was identified that most nurses were unhappy with the depth of their preparation regarding pharmacology.

#### **2.2.4 Distractions and Interruptions**

The administration of medications in the acute care setting involves a series of physical and cognitive processes, and frequently occurs in a changing and chaotic environment (Potter, Wolf, Boxerman, Grayson, Sledge, Dunagan, et al., 2005). In the literature review by O'Shea (1999) on contributing factors associated with medication errors, five research articles were found that identified distractions and interruptions as factors contributing to medication errors (Conklin, MacFarland, Kinnie-Steeves, & Cheng, 1990; Walters, 1992; Davis, 1994; Segatore, Miller & Webber, 1994; Williams, 1996). In addition, two more recent articles were found on this topic (Cohen, Robinson, & Mandrack, 2003; Potter et al., 2005).

The research of Potter et al. (2005) looked at the cognitive work of nursing in the acute care setting and how environmental factors create disruptions that increase the risk for medical errors. This was an ethnographic study that used a mixed methodological approach, using both quantitative and qualitative data collection, involving a convenience sample of seven registered nurses. In this study, the researchers combined human factors engineering (HFE) and qualitative observation. HFE has been widely used in industry to improve complex systems operations and to decrease cognitive errors related to person-machine interface. HFE techniques provided data about the psychomotor activities of nursing care, time measurements, and motion patterns. By combining qualitative observation with HFE techniques, the researchers were able to capture select cognitive activities within nursing. Together, a RN researcher and a human factors engineer shadowed each RN during four to nine hours of patient care activities. The researchers of this study found that all seven nurses practiced multitasking, on average

walking from one location to another 13 times every hour, and performing approximately two activities before moving on to the next location. It was also found that the seven RNs averaged nine cognitive shifts per hour, meaning each RN was required to change focus from one patient to another about once every six to seven minutes. In addition, the HFE observed an average of 261 interruptions or (5.9 per hour), while the RN researcher observed an average of 151 or (3.4 per hour). Interruptions occurred in the medication room (22%) during medication preparation. Interruptions within the medication rooms were staff questions, missing medications or administration supplies, phone calls or pagers alarming, with no attempt by the nurses to control interruptions during medication preparation. The researchers also identified that most medication rooms were highly visible and located in high traffic areas. The aforementioned findings suggest a need to identify interventions to reduce or eliminate interruptions during the medication process and thereby reduce the risk of errors (Potter et al., 2005).

Lastly, a survey by Cohen, Robinson and Mandrack (2003) surveyed 775 nurses about medication errors. Nurses identified the top five reasons for medication errors. The top reason identified by the respondents was distractions and interruptions during medication administration. Other important factors identified included: inadequate staffing and high nurse/patient ratios, illegible written medication orders, incorrect dosage calculations, and similar drug names and packaging.

The aforementioned studies indicate that distractions and interruptions appear to be significant variables associated with medication errors. These studies identify that, when assessed with previous studies, there are multiple areas for intervention in reducing medication errors.

### **2.2.5 Workload and Staffing**

As cited in the literature reviews by both O'Shea (1999) and Armitage and Knapman (2003), four research studies identified that workload and staffing patterns appear to affect the medication error rate (Conklin, MacFarland, Kinnie-Steeves, & Chenger, 1990; Leape, Bates, Cullen, Cooper, Demonaco, Gallivan, et al., 1995; Roseman & Booker, 1995). Only one research study cited in the reviews found no relationship between workload, staff absenteeism, relief duty and medication errors (Taunton, Kleinbeck, Stafford, Woods, & Bott, 1994).

The 1995 study by Roseman and Booker was especially interesting. They studied nine workload factors along with seasonal changes in daylight and darkness in relation to medication errors over a five year period in Alaska. These researchers found that the incidence of medication errors increased with the number of patient days per month and the number of shifts temporary staff worked. In addition, medication errors decreased when permanent staff worked overtime. Lastly, a seasonal pattern of medication errors was found, with 95% of errors most likely to occur in the midwinter months, with errors markedly increased after a delay of two months from the point of minimal daylight.

A more current review of the literature found seven research articles on the topic of workload and staffing, with the majority of this research looking at medication errors as a patient outcome (Blegan, Goode, & Reed, 1998; Blegan & Vaughn, 1998; Hal, Doran, & Pink, 2004; Seago, Williamson, & Atwood, 2006; USP, 2000; Whitman, Kim, Davidson, Wolf, & Wang, 2002). Only one research article found no correlation for percentage of RN hours and medication errors (Potter, Barr, McSweeney, & Sledge, 2003). The study by Blegan, Goode, and Reed (1998) on nurse staffing and patient outcomes utilized one



tertiary care center using 42 inpatient units. Their objective was to identify the relationship among the total hours of nursing care, RN skill mix, and adverse patient outcomes. Adverse outcomes included medication errors per nursing unit, patient falls, skin breakdown, patient and family complaints, infections, and deaths. Controlling for patient acuity, the researchers found the proportion of hours of care delivered by RNs was inversely related to the unit rates of medication errors, pressure ulcers, and patient complaints. A surprising finding in the research was that as the RN proportion of care increased above 87.5%, adverse outcome rates increased.

A multisite study by Blegan and Vaughn (1998) also looked at staffing and patient outcomes. In this study, 39 inpatient units from 11 different hospitals were utilized for data collection. Results from this study were similar to the aforementioned study by Blegan et al. (1998) in that the researchers again found a higher RN staffing mix was significantly associated with lower rates of medication administration errors, pressure ulcers, and patient complaints. Again, similar to the previous study, as the proportion of RNs increased from 85% to 100%, medication errors increased. Several hypotheses that the researchers suggest for this result included: heightened vigilance, where an increased number of RNs result in increased reporting rates; increased severity of patients' conditions requiring more complex medications increasing the risk for error; or with higher RN staffing ratios there may be less total personnel needed for the best possible patient care (Blegan & Vaughn, 1998).

In 2000, the USP released the *Summary of 1999 Information Submitted to MedMarx(SM): A National Database for Hospital Medication Error Reporting*. This report was released one year after the IOM drew national attention to medical errors

occurring in hospitals throughout the U.S. The report summarized the 1999 data of 6,224 medication error records from 56 facilities, including community, government and teaching hospitals. This report identified the primary contributing factors to medications errors were distractions and workload increases.

One longitudinal study looking at nurse staffing and patient outcomes was found by Seago, Williamson, and Atwood (2006). In this study, the researchers utilized three adult medical-surgical nursing units in one university teaching hospital over a four year period. They, too, compared nurse staffing and positive patient outcomes, but also explored a new outcome, failure to rescue (FTR), particularly FTR from medication errors. The results showed that as non RN hours of care per patient day increased, there was an increased FTR from medication errors.

Additionally, two more recent studies evaluated the effect of nurse staffing and patient outcomes. The study carried out in Canada by Hall, Doran, and Pink (2004) utilized 77 adult medical, surgical and obstetric inpatient units in 19 urban teaching hospitals. By utilizing the hospitals' health records department, the researchers found the lower the proportion of RNs and registered practical nurses (RPNs) employed on a unit, the higher the number of medication errors and wound infections. Furthermore, Whitman, Kim, Davidson, Wolf, and Wang (2002) looked at the impact of staffing on patient outcomes across specialty units. The researchers utilized the data from 95 patient care units (cardiac and non-cardiac intensive care, cardiac and non-cardiac intermediate care, and medical- surgical units) from ten acute care hospitals, looking at central line blood infections, pressure ulcers, falls, medication errors, and restraint duration rates.

These researchers found a significant inverse relationship in medication errors with the number of RNs and LPNs in both the cardiac and non-cardiac intensive care units.

Lastly, a study by Potter et al. (2003) also looked at nurse staffing and patient outcome relationships. Adverse occurrences investigated included patient falls and medication errors. Medication errors were identified through the hospital's incident reporting system and through the pharmacy's audit system. Data were collected from 32 inpatient units over a period of 12 months. These researchers found no significant correlation for percentage of RN hours and medications errors or falls.

In summary, workload and staffing levels appear to be significant variables associated with medication errors and other patient outcomes. As patient acuity continues to increase in the inpatient setting, tracking of these indicators over time will become increasingly important for appropriate allocation of personnel, total hours of care needed, and optimal skill mix (Blegan & Vaughn, 1998).

### **2.2.6 Nursing Shift Work**

In the literature reviews by both O'Shea (1999) and Armitage and Knapman (2003), several older research studies are cited that identify a number of working conditions that could lead to medication errors (Girotti, Garrick, Tierney, Chesnick, & Brown, 1987; Markowitz, Pearson, Kay, & Lowenstein, 1981; Pearlson, 1988; Raju, Kecskes, Thorton, Perry, & Feldman, 1988). In a study from the United Kingdom, Raju et al. (1988) identified that medication errors occurred more often on the day shift as compared to the evening or night shift. This may possibly be due to the large number of prescriptions ordered and administered during this part of the day or a lower rate of identification of errors on the night shift, perhaps due to fatigue. Yet, results from the

study by Girotti et al. (1987) identified that the opportunity for error, also based on number of prescriptions ordered and administered, was very similar between day and night shifts, though significantly more errors did occur on the day shift. In addition, an association was identified between the number of admissions, deaths, and discharges per shift and the number of errors which occurred. Interestingly enough, Markowitz et al. (1981) found that nurses on the day shift were more knowledgeable regarding medications than nurses on other shifts.

A more recent literature search on this topic identified three research articles (Gold, Rogacz, Bock, Tosteson, Baum, Speizer, et al., 1992; Scott, Rogers, Hwang, & Zhang, 2006; Suzuki, Ohida, Kaneita, Yokoyama, & Uchiyama, 2005). Gold et al. (1992) looked at rotating shift work and accidents related to sleepiness in 593 hospital nurses. The researchers found that those nurses who rotated (work day and night shifts in one month) had reported more sleep/wake cycle disruption, along with nodding off more at work. In addition, these nurses were two times more likely to nod off while driving to or from work and had almost two times more reported medication errors and near misses due to sleepiness.

A 2005 study carried out in Japan by Suzuki et al. looked at daytime sleepiness and occupational accidents among 4,279 hospital nurses. The authors found excessive daytime sleepiness (EDS) among 26% of hospital nurses. Using multiple logistic regression, significant associations between EDS and occupational accidents were identified and included: (a) medication administration errors, shift work, and age; (b) incorrect operation of medical equipment, EDS, and age; and, (c) needle stick injuries, age, and EDS.

Lastly, a more recent study by Scott et al. (2006) looked at the effects of critical care nurses' work hours on vigilance and patients' safety. The researchers utilized a random sample of critical care nurses in the U.S. Data were collected in log books filled out over a 28 day period by 502 nurses for a final response rate of 43.7%. Though results did not find an association between decreased vigilance and increased risk of errors, the researchers did identify the following results: (a) nurses left work at the end of their shift only 13% of the time, averaging almost an additional hour with each shift worked; (b) almost two-thirds of the nurses had difficulty staying awake at least once during the 28 day period, with 20% of nurses falling asleep at least once during their shift; and (c) greater than one-quarter of the nurses made at least one error, while one-third reported making one near miss during the study period, with the majority of these errors associated with medication administration. In addition, the risk for making an error almost doubled when nurses worked over 12.5 hours or worked more than 40 hours per week.

### **2.2.7 Quality of Prescriptions**

The quality of written prescriptions has been cited frequently in the literature as a contributing factor to medication errors. Prescriptions are a form of communication and have been a legal responsibility of physicians, which now includes nurse practitioners (Armitage & Knapman, 2003; O'Shea, 1998). A poor quality prescription, or one that is illegibly written, increases the risk and responsibility of the nurse who is accountable for administering that medication (Howell, 1996). O'Shea (1998) and Armitage & Knapman (2003) identified six articles relating to poor quality of written prescriptions (Cavel & Hughes, 1998; Cooper, 1995; Farrar, 1999; Howell, 1996; Kawamura, 2001; Lyons,

Payne, McCabe, & Fielder, 1998). A current review of the literature found an additional seven research articles related to poor quality of prescriptions in the acute care setting (Allison, Szeinbach, & Schneider, 2005; Bobb, Gleason, Husch, Feinglass, Yarnold, & Noskin, 2004; Davydov, Caliendo, Mehl, & Smith, 2004; Dean, Schachter, Vincent, & Barber, 2002; Kripalani, Badanapuram, & Bell, 2007; Lesar, Briceland, & Stein, 1997; Lesar, Lomaestro, & Pohl, 1997).

Lesar, Briceland, and Stein published a 1997 study on factors related to medication prescribing. In this research from a 631 bed tertiary care teaching hospital, every third prescribing error which was detected and diverted by a pharmacist was then reviewed by a physician and two pharmacists for factors related to the error. The most frequent errors identified included: alteration of drug dose needed due to hepatic or renal function, patient history of allergy to the same medication class, using the wrong drug name, dosage form or abbreviation, incorrect dosage calculation, and atypical or unusual critical dosage frequency considerations. A nine year study by Lesar, Lomaestro, and Pohl (1997) carried out from January 1987 through December 1995 found that the rate of errors per written order, per admission, and patient day significantly increased during the duration of the study. The annual number of errors in 1987 at 522 increased to 2,115 errors in 1995, all with the potential for adverse patient consequences. The most frequent type of errors included: dosing errors, prescribing medications to which the patient was allergic, and prescribing inappropriate dosage form. In addition, a 2004 study by Bobb et al. also found prescribing errors to be common in the inpatient setting. In a 700 bed academic medical center, pharmacists saved all orders that contained a prescribing error for one week (1,111 errors) for a rate of 62.4 errors per 1,000 medication orders. Of

these errors, 30.8% were considered clinically significant with most relating to antibiotic orders, incorrect dose, and medication knowledge deficiency.

A study carried out in the U.K. by Dean et al. (2002) reviewed the causes of prescribing errors by interviewing those who made an error. Pharmacists identified 88 potentially serious prescribing errors, which resulted in 44 interviews. The researchers found that prescribing errors were made due to slips in attention (due to business or interruptions) or because prescribers did not follow relevant rules of prescribing (absence of necessary knowledge). In addition, an audit of inpatient prescriptions was carried out on a psychiatric ward in a U.K. hospital after identifying baseline information and providing a refresher on prescribing guidelines (Kripalani et al., 2007). Overall, though only slight improvement was found in the prescriptions, the researchers believed trainees coming into a new specialty area did show significant improvement in regards to following prescription guidelines, along with also identifying the need for minimal national prescription guidelines.

An interesting study by Allison et al. (2005) reviewed the accuracy of medication orders given over the phone. In recent years, when oral medication orders are taken by a nurse over the phone it is limited to times of emergency or in situations when there is no other way to efficiently communicate (Allison et al., 2005). The purpose of this study was to identify conditions that could affect the accuracy in which phone orders are transmitted, received, and documented. Data for this cross-sectional study was gathered on a 16 item questionnaire collected by 76 hospital pharmacy directors or managers randomly selected from a national database then disseminated to their staff pharmacists. The final response rate was 30.4%, after a two wave mailing. The results of this study

identified that pharmacists spent an average of 35 minutes per 8-hour shift and an average of 42 minutes per 12-hour shift resolving problems with telephone transmitted medication orders. Furthermore, 31 dispensing errors occurred per month with an average of 3.6 errors attributed to telephone orders. The most significant barriers that affected pharmacy accuracy included: background noise (people talking, interruptions), information exchange (lack of knowledge of caller and pharmacist about patient), and scheduling (number of technicians working in pharmacy, time of day of call).

Lastly, a study by Davydov et al. (2004) looked at the possible correlation between the frequency and significance of prescribing errors and the number of hours worked during a 24-hour shift by hospital house staff. This observational trial was conducted on two internal medicine units at an academic medical center. All orders written by the house staff were collected over approximately a one month period and reviewed for errors. A total of 45,366 orders (medications, laboratory, diagnostic, nursing) were entered over the study period, with 498 errors identified. Researchers felt 77% of the errors could have resulted in a significant adverse outcome if they had reached the patient. The most frequent errors included: wrong dose (18%), wrong dosage frequency (15%), and duplicate orders (155). There was no correlation found between number of hours worked by house staff during a 24-hour period and the frequency or significance of prescribing errors. In summary, poorly written prescriptions appear to contribute to the risk of a medication error in the acute care setting.

#### **2.2.8 Policy and Procedures**

According to O'Shea's (1999) review, the literature suggests that many medication errors are the result of failure to follow policy (Conklin et al., 1990; Fuqua &



Steven, 1988; Keill & Johnston, 1993; Long & Johnson, 1981). In contrast to this, a 1995 article by Cooper suggests that some policies may be impractical and burdensome for nurses with heavy workloads and high patient turnover rates. Baker and Napthine (1994) imply that rules can lead to ritualistic practices which can lead to error. Others suggest that structured protocols threaten nurses' ability to think and take initiative, especially for those who are more experienced (Greenwood & King, 1995; Mulhall, Alexander, & Le May, 1997; Mayo, Chang, & Omery, 2002), while Wolf (1989) argues that policies and procedures provide nurses with a sense of responsibility and security.

In reviewing more current literature, only one new research article was found regarding the use of protocols to manage patients' medications (Manias, Aitken, & Dunning, 2005). In this qualitative study, the researchers were specifically looking at how graduate nurses adhered to various protocols related to medication administration activities. These researchers followed 12 nurses during direct patient care in medical, surgical, and specialty wards during a two-hour period when medications were being administered. Following this activity, in-depth interviews were conducted with each nurse. The researchers identified a wide variation in the adherence to medication protocols: (a) graduate nurses adhered to medication protocols when they were perceived not to interfere with other nursing activities; (b) when the protocols helped the nurses with autonomous decision making; and, (c) if there was a decreased likelihood disciplinary action would be taken if an error was made. It was also identified that experienced nurses should model effective protocol use and provide peer support to newer colleagues as an important component of quality care (Manias, Aitken, & Dunning, 2005). To summarize, the research demonstrates both pros and cons with the

use of medication administration protocols, with less experienced nurses finding increased use of protocols for help with clinical decision making.

### **2.2.9 Length of Experience**

The question being addressed by both O'Shea (1999) and Armitage and Knapman (2003) in their literature reviews was: Who is making the medication errors, experienced or novice nurses? Only two studies from the aforementioned reviews addressed this issue (Farrar, 1999; Walters, 1992). As cited by O'Shea (1999), a 1992 study by Walter on the occurrence and reporting of medication errors, found that RNs over the age of 35 years reported making fewer errors than those under age 35, though this result was not statistically significant. In addition, the researcher found fewer medication errors were reported by nurses who had been in nursing over one year or employed in the same hospital for more than one year. The author concluded that nurses new to a hospital system were more likely to make medication errors, probably due to a different or new environment. Farrar (1999) also concluded that error occurrence increased as familiarity of the nurse administering the medications decreased.

A current review of the nursing medication error literature found no research articles addressing length of experience as an independent variable, though age and length of experience are frequently addressed as demographic factors. In summary, length of experience as a contributing factor to medication errors appears to be inconclusive.

## 2.3 Safety Systems

### 2.3.1 Standards of Practice

Prior to the year 2000, when the IOM released its publication *To Err is Human: Building a Safer Health System* and the establishment of the first set of National Patient Safety Goals by JCAHO in 2002, nursing professionals have been following standard actions to ensure safe nursing practice (Perry & Potter, 2006). To ensure safe medication administration, nurses have followed and continue to follow a standard called the “six rights” of medication administration. The six rights of medication administration that are checked prior to giving medication to all clients include:

1. the *right* medication
2. the *right* dose
3. the *right* client
4. the *right* route
5. the *right* time, and
6. the *right* documentation, which immediately follows the administration of the medication (Perry & Potter, 2006).

A second important practice nurses continue to follow prior to administering medications is reading the label on the medication container and comparing it with the medication administration record (MAR) at least three times (Perry & Potter, 2006). These three times include: when the nurse is removing the medication from the drawer, when the nurse is placing the medication in a cup or syringe in preparation for use, and just before administering the medication to the client (Perry & Potter, 2006). Current practice also includes checking two patient identifiers prior to administering medication,

such as the patient's name band and having the patient pronounce his or her name when the patient is physically and mentally able to do so (Perry & Potter, 2006). Other steps professional nurses take to prevent medication errors include: not allowing other activities to interrupt medication administration, double checking all calculations with a second nurse or pharmacy, clarifying illegible medication orders, questioning an unusually large or small dose of a medication, and keeping updated on medications frequently administered (Perry & Potter, 2006).

### **2.3.2 Bar-Code Medication Administration/Verification/Bar-Code Point of Care**

Bar-code medication administration (BCMA) or bar-code verification (BCV) is one of the new technologies that has been recommended to reduce medication administration errors (Bates, 2000). BCMA is used to electronically validate each medication prescription before it is administered at the bedside to the patient by the nurse (Lawton & Shields, 2005). Prior to use of this system, a computerized physician order entry system must be in place at the hospital. A nurse can then use a hand held computer to scan the patient's bar-coded identification bracelet and the bar coded unit dose medication package against an electronic MAR (Lawton & Shields, 2005). If this three-way check system confirms the correct medication, dose, patient, and time, the system charts the information on the MAR. If a discrepancy is found, the hand held computer will sound an alert and generally flash an error warning for the nurse to stop the administration of the medication. It is then possible for the nurse to identify the reason for the warning, correct the mistake, make revisions to the system if necessary, or stop the medication administration (Lawton & Shields, 2005).

Currently, approximately 5% of United States hospitals use a bar-coding medication system (Wright & Katz, 2007). A review of the literature identified five research studies associated with its use. An article by Coyle and Heinen (2005) identified the BCMA system was first introduced between 1999 and 2000 through the Department of Veterans Affairs Medical Center in 161 Medical Centers and Health Systems. The authors found that the BCMA system demonstrated increased safety for both the patient and the nurse. After three years of use, 97% of the nursing staff agreed actual and potential medication errors decreased. Over a six-year period, 549,000 medication errors were prevented in the Eastern Kansas Veteran Affairs Health Care System. By using BCMA, the Martinsburg, West Virginia site decreased medication errors by 23% during the first year and by 66% over a five-year period (Coyle & Heinen, 2005).

Lawton and Shields (2005) assessed the impact of BCV in a small private hospital opening a new 36 bed combined intensive care and medical-surgical nursing unit. During the medication administration process, the BCV system documented any potential errors. Other errors that occurred outside the administration process were tracked by the hospital's voluntary event reporting system, along with interviewing nurses and pharmacists. Reported errors and near misses were analyzed and verified over a nine month period once the system was implemented. During the study period, there were 1,438 patient admissions to the unit, with an average daily census of 27 patients. The system detected and prevented 27 potential medication errors. During the same time period, 228 medication errors were documented that originated from the medication process other than administration, such as prescribing, order communication, and distribution. The aggregate medication error rate on the unit equaled 16% (medication

errors/admissions). The relative risk associated with medication events was reduced 11% with the BCV system (Lawton & Shield, 2005).

A 2006 study by Patterson, Rogers, Chapman, and Render looked at compliance with intended use of BCMA in both the acute and long-term care settings. The aim of this prospective ethnographic study was to identify the types and extent of workaround strategies used in acute care hospitals, along with long-term care that had a well established bar code based point of care system. The sites utilized for this research included three hospitals, with at least one acute care, and one long term care unit included from each hospital. Only nurses experienced with the BCMA system, both RNs and LPNs were observed in this study. The observers (data collectors) kept detailed, hand written field notes of both verbal and nonverbal behaviors, along with information from the BCMA system and related software. When needed, interviews were conducted with the nurses during the observation time to improve understanding of strategies and perceived barriers and facilitators affecting compliance with recommended practices. A total of 15 acute care nurses were observed for 17 medications passed over 42 hours, along with 13 long term care nurses for 15 medications passed over 37 hours. Two major areas of workaround strategies were identified: patient identification and medication administration. When using the BCMA system, the nurses were to identify the patients by scanning the Social Security Number (SSN) bar coded on the patient's wristband, which then displayed an electronic MAR (eMAR). The study found that seven nurses in acute care and seven nurses in long-term care at different times bypassed this step and would type the SSN into the system for efficiency reasons. Five nurses in long-term care scanned a "surrogate" armband not on the patient's wrist, also finding the alternative

procedure to be more efficient. With the BCMA system, the appropriate sequence of medication administration is to scan the patient's wristband and then scan all of the medications due for a specific patient, opening the medication packet, and then administering the medications immediately to the patient. It was found that one acute care nurse out of 15 and 10 long-term care nurses out of 13 pre-poured medications. This procedure is strongly discouraged because it entails scanning medications for multiple patients before medications are administered to the first patient. In addition, in long-term care, two nurses scanned and prepared all of the medications for their patients as their routine procedure. This strategy made it appear as if the medications were administered and documented as being given "on time," which the nurses felt was an impossible task to accomplish. Utilizing this strategy, the nurses avoided having to type in mandatory reasons for every late medication. All three of the aforementioned strategies reduced the safety and effectiveness of BCMA technology (Patterson et al., 2006).

An earlier observational, ethnographic study by Patterson, Cook and Render (2002) looked at identifying side effects from introducing BCMA. In this study, seven nurses were observed for a total of 21 hours during ten medications passed at one hospital prior to BCMA implementation. Following BCMA implementation, 26 nurses were observed for a total of 60 hours during 23 medications passed at three hospitals. One trained ethnographic observer familiar with complex settings conducted all of the observations. Observations were done over a 13-month period, beginning immediately after implementation of the system, after initial problems were resolved, and after the system was fully adopted. The observer also viewed computerized order entry by two physicians over a two-hour period and order verification by five inpatient pharmacists

and two pharmacy technicians over a ten hour period at one hospital. In addition, interviews were conducted with practitioners, nurse managers, and computer support personnel. The data was then analyzed for emerging patterns and themes. The findings revealed five negative side-effects following the introduction of BCMA. First, nurses were confused by the automated removal of medications by BCMA. An example of this is when an antibiotic was not available for administration and dropped from the BCMA screen as a result of an automatic stop order. Another example included a chemotherapy medication being automatically dropped due to a delay in administration as a result of the lack of an intravenous site. Both medications were intended to be given and were administered, but the fact that they were dropped from the BCMA created a new path for potential missed medications. A second side-effect identified was degraded coordination between nurses and physicians due to the lack of a paper MAR. Many physicians were not aware of how to access information regarding medications with the BCMA system and discovered it was much more labor intensive to review medication orders. As a result, the physicians found themselves reviewing medication orders less frequently unless a specific question was asked, as compared to when the paper based system was in use. The third side-effect identified was that nurses dropped activities to reduce workload during busy periods of medication administration. These strategies increased efficiency, but worked around the intended use of BCMA. An example of one of these strategies was to type in the patient's identification number versus scanning the patient's wristband. The fourth side-effect found, was increased prioritization of monitored activities during goal conflicts. To explain, after BCMA implementation, many nurses became much more aware of and anxious regarding the timeliness of their medication



administration activities. Medications should generally be administered 30 minutes before and up to 60 minutes after the scheduled administration time. Due to the electronic documentation associated with BCMA, along with the fact that an explanation for lateness of a medication must be typed into the system, analysis of timeliness could be monitored much more easily than with the paper system. It was stated by one nurse, that nurses in general would be more likely to delay other priority nursing activities, such as fixing a patient's restraint that is at risk of falling, to ensure timeliness of their medication administration. The last negative side-effect associated with bar code implementation was the decreased ability to deviate from routine sequences, meaning that a non-routine sequence becomes more difficult to perform. An example would be a "taper dose" order written by a physician (e.g., prednisone taper: start at 60 milligrams (mg), decrease 10mg every other day until at 10mg, then decrease to 5mg for 2 days). Prior to the BCMA system, this order would take the pharmacist about one minute to process and pass the order on as a free text note to the nursing personnel. After BCMA implementation, the pharmacist took approximately 17 minutes to break down the order into specific daily orders that were able to be scanned, for a total of 14 new orders before the discontinuation of the medication. Though these negative side-effects associated with BCMA could create new paths for potential errors, the researchers suggested that design revisions of the system, development or modifications in organizational policies, and "best practice" training for involved healthcare personnel could reduce or eliminate these problems before a medication incident occurred (Patterson et al., 2002).

A 2002 study by Carroll was done to determine perceptions of pediatric nurses toward the bar code point of care (BPOC) medication administration system and to

describe the trend of medication errors before and after implementation of BPOC. This study was carried out in one pediatric hospital, using a pre-test/post-test survey design using a Likert-type response scale and open ended questions. Subjects included nurses ( $n = 550$ ), pharmacists ( $n = 25$ ), and respiratory therapists ( $n = 25$ ). The pre-test return rate was 31% ( $n = 136$ ), post-test return rate equaled 25%. Data analysis of the pre- and post-tests revealed statistically significant results for three areas: (a) effect of new system on medication errors, where staff felt errors had not decreased as much as they thought they would; (b) staff time using system, where staff perceived the system increased time; and (c) patient satisfaction, where staff perceived patient satisfaction would increase more prior to implementation of the system than after they had actually used the system. Following bar code implementation, qualitative data revealed the staff felt they spent more time with medication administration with an increase in safety and that the system did take away time from patient care. In addition, BPOC reports noted 103 actual medication errors and 76 medication errors that were averted following a system generated warning. In addition, 39 of the 76 medications did not have a proper physician's order, and 37 of the 76 were prevented from being administered to the wrong patient. Lastly, 385 events that appeared in the BPOC reports, but were not medication errors, led to an examination of the practices in the nurses' work environment to enhance the environment for the nurses and to improve patient outcomes (Carroll, 2002).

Eisenhauer, Hurley, and Dolan (2007) appear to have published the most recent study related to bar code point of care technology. The purpose of this study was to document nurses' reported thinking processes during medication administration before and after implementation of bar code technology. Using retrospective, semi-structured

taped interviews, the researchers documented the thinking processes of 40 practicing RNs, who worked in a large tertiary care teaching hospital, two to twelve weeks before implementation of bar coding technology and then again four months after implementation. Content analysis identified ten categories of nurses thinking during the medication administration process. (See definitions and frequencies listed in Table 4.)

The ten categories of nurses' thinking during medication administration indicates the intellectual complexity of the process, showing that safe medication administration is more than a technical psychomotor task. Most participants' thinking did not change following bar code implementation. Nurses did report spending less time and effort checking when medications were last given, since this information was automatically recorded in the eMAR. The computer program was also able to remind nurses of upcoming medications, so the nurses felt less likely to miss a medication that was due. In addition, it was more efficient for nurses to find drug information or patient information, such as recent lab values associated with the medication administration pass, because it was accessible in the computer. Lastly, the nurses noted much less ambiguity, frustration, and room for error, since physician medication orders were computerized versus hand written.

**Table 4-2**

*Categories of RNs' Thinking During Medication Administration*

Category	Definition	Frequency
Communication	Nurses and others sharing patient data and their interpretation to ensure that a drug was safe or if a change in medication or dose was indicated	145

Dose-time	Nurses' judgments about the timing of PRN medication (e.g., analgesics, antiemetics, drugs for sedation) or about the amount of medication to give within prescribes parameters (e.g., blood pressure medications, insulin).	121
Checking	Nurses verifying the correctness and appropriateness of a component of the medication administration process.	109
Assessment	Nurses' reasoning related to detection and interpretation of patients' signs and symptoms potentially related to patients' needs for medication	96
Evaluation	Nurses' judgment related to whether the medication was achieving the desired therapeutic effects.	79
Teaching	Nurses providing the patient or family with information about medications based on medication information needs of patient or family, appropriateness of the teaching moment, and capacity to understand.	56
Side effects	Nurses monitoring for, preventing, or acting to mitigate adverse effects of medications.	40
Work around	Nurses not following standard procedures either for the benefit of the patient or for the convenience of the nurse.	37
Anticipatory problem solving	Nurses' consideration of the future course of events based on patients' patterns of response, or scheduling of diagnostic test or therapeutic procedures.	27
Drug administration	Nurses giving a medication to the patient.	21

*Note.* From "Nurses' Reported Thinking During Medication Administration," by L. A. Eisenhower, A. C. Hurley, and N. Dolan, 2007, *Journal of Nursing Scholarship*, 39(1) p. 84.

### **2.3.3 Computerized Physician Orders**

Another safety system beginning to be used in the acute care setting to reduce medication and medical errors is the computerized physician order entry system (CPOE). This system is considered a key patient safety initiative advocated by the Leapfrog Group, composed of major companies and large private and public healthcare purchasers. This group initially formed following the release of the 1999 IOM report (Leapfrog Group). CPOE is a computerized system in which physicians write orders online. It improves physician ordering by ensuring complete, unambiguous, and legible orders (Bates et al., 1999). In addition, the computer software has the capabilities to help the physician at the time of ordering by suggesting appropriate medication doses and frequencies, displaying relevant laboratory data, screening medication orders for allergies, and drug to drug and drug to laboratory alterations (Bates et al., 1999). This feature of the computer program is called the clinical decision support systems (CDSS), though not all programs are equipped with this added element. A review of the literature on the topic of CPOE revealed one review article and three research studies.

In the 2003 review by Kaushal, Shojania, and Bates, the researchers identified and evaluated five studies that assessed the effect of CPOE and seven trials that assessed isolated CDSS effect on medication safety. The results showed that CPOE and isolated CDSS have the ability to substantially reduce medication error rates. In addition, the authors identified that many of the studies evaluated did not have adequate power to detect differences in adverse drug events and only assessed a small number of “homegrown” systems.

A 2002 study by Mekhjian et al., not included in the above review, looked at the benefits of CPOE and eMAR on the delivery of health care. The settings for this study were inpatient nursing units in an academic health system. The study utilized before and after comparisons of CPOE for periods of 10 to 12 months across units and hospitals within the system. Findings of the study related to medication administrations showed a statistically significant reduction in medication turn-around times (64%) from 5:28 hours to 1:51 hours. In addition, CPOE combined with eMAR eliminated all physician and nursing transcription errors.

While studies of CPOE in the adult populations have increased, little is known about its effect on clinical practices in the neonatal intensive care (NICU). Codero, Kuehn, Kumar, and Mekhjian (2004) designed a retrospective study to identify the impact of CPOE on NICU practices. The study was based on pre- and post-CPOE comparisons in medication error rates and on the time interval for initiation and completion of pharmacy orders. The two medications followed in this study were caffeine citrate, which is dispensed by the pharmacy (versus being kept on the unit) and is administered with a loading dose, and gentamicin, which is dosed according to weight and given empirically on admission to the NICU and later if sepsis is suspected. Results of this study showed significant reductions in medication turn-around times for the loading dose of caffeine with pre-CPOE at 10.5 hours and post-CPOE at 2.8 hours. Accuracy of gentamicin dosage on admission to the NICU also improved, as pre-CPOE there was 5% over-dosage, 8% under-dosage, and 87% correct dosages. Post-CPOE, no gentamicin dosage errors occurred at the time of admission to the unit. In neonates

suspected of having sepsis, gentamicin dose was inaccurately calculated pre-CPOE in two of 31 infants, with no errors post-CPOE (Codero et al., 2004).

Lastly, a study by Dykstra (2002) looked at the effects of CPOE on communication. The data were collected through participant observation, focus groups, and oral history techniques from four distinct sites across the U.S. The data from this study were initially examined for success factors for CPOE and then were then re-examined for communication related issues. The re-examination revealed significant impacts on communication channels and the relationships between physicians and nurses, pharmacy roles, and patients. Several examples from participants have been included: “The computer gives a false sense that communication is happening. You enter it and think it went to the right place.” “The end result is „oh put it in the computer rather than tell me about it.”, “[Y]ou start doing physician order entry, you move away from the ward into a room and now you eliminate the sense of team, and the kind of human communication that was essential....You create physical separation.”, “[P]eople aren’t around much to ask questions to and get this interaction with.”, and lastly, “[W]e’re stuck at the computer all day long entering words, communicating through the computer... the personal communication is worse. You know, actually speaking to the nurse” (Dykstra, 2002, p. 231).

#### **2.3.4 Smart Infusion Pumps**

Intravenous (IV) infusion pumps have been used for many years to administer complex infusions of medications. Although they were designed to be easy to use, they have been associated with serious programming errors, leading to over-dosing or under-dosing of medications (Crawford, Mullan, & Vanderveen, 2005). In fact, 35% of all

medication errors that resulted in serious harm were due to IV pump errors, with the most common error due to incorrect programming of the parameters into the pump (Tourville, 2003). Until recently, infusion pumps were unable to alert nurses about incorrect programming. These older pumps are now being replaced by computerized “smart” pumps that have been associated with a reduced risk of error in the administration of IV infusion medications (Crawford, Mullan, & Vanderveen, 2005). These computerized pumps have comprehensive drug libraries, dosing limits, and best practice guidelines. Each hospital develops its own data set to include medication names, concentrations, dosing units, and dose limits, and then loads the data into each pump. In the event that a program is entered by the nurse at the bedside and is found to be outside the hospital’s predefined limits, the pump is able to alert the nurse. These pumps are also able to match performance criteria to the population being treated, such as infants or the elderly, who would require different infusion rates and doses. In addition, some pumps are able to maintain an electronic record of all programming errors and following actions taken by the nurse, which has been useful in continuous quality improvement programs (Crawford, Mullan, & Vanderveen, 2005).

A review of the literature found five research articles on the use of smart infusion pumps. Four of the research studies found that continuous infusion medication errors could be reduced with the use of smart pumps (Fanikos et al., 2007; Jacobs, 2005; Larsen, Parker, Cash, O’Connell, & Grant, 2005; Rothschild et al., 2005). In contrast, the research study by Husch et al. (2005) reported that smart pumps would need to be interfaced with other safety systems such as the eMAR, CPOE, BCMA, or pharmacy information systems before meaningful improvements in safety would occur. Though the



study by Rothschild et al. (2005) did find that intravenous medication errors could be detected using smart pumps, the researchers did not find a measureable impact between the control and intervention periods on the serious medication error rate (cause of injury). Most likely, this is due to the ease of bypassing the drug library during set-up of the pump and the ability of the nurse to override set parameters (Rothschild et al., 2005). In the study by Fanikos et al. (2007), the researchers looked at smart pump infusion technology on administration of intravenous anticoagulants. Interestingly, researchers found the highest number of alerts occurred between the hours of 2 p.m. and 4 p.m. On most nursing units, this time period has a high rate of admission and transfers, typically is the peak medication ordering time, and frequently involves a nurse shift change. Lastly, in the research study by Larsen, Parker, Cash, O'Connell, and Grant (2005) on the use of smart pump technology in pediatric patients, the researchers not only looked at the use of smart pumps to reduce infusion errors, but also adopted standard drug concentrations for their pediatric patient population, along with re-designing a user-friendly medication label. These researchers also indicated ideal implementation includes standardized staff education using scenario-based evaluation of smart pump technology, national standardization of drug concentrations for the pediatric population, and interfacing with CPOE and eMAR, along with rigorous error and reporting systems (Larsen et al., 2005).

### **2.3.5 Automated Dispensing Systems**

Automated dispensing systems (ADS) have been in limited use for about three decades, but became a mainstream health care delivery technology in the 1990s (Tallon, 1996). An ADS is an automated pharmacy medication and supply preparation and management device designed to achieve computerized control of unit dose medication

dispensing, with all procedures controlled electronically through the patient profile (Novek, Bettess, Burke, & Johnston, 2000). These systems give the nurse access to a specific dose of medication the patient requires and to the patient's whole medication profile when integrated with pharmacy. Information is entered onto a screen identifying a patient and then the automated unit delivers the specified patient medication (Tallon, 1996). An ADS can be centrally located in a pharmacy or decentralized (unit based). For the purpose of this paper, the focus will be on the decentralized unit, which the nurse would access for medication administration activities. An ADS appears somewhat like a large automated teller machine with a screen, keyboard, and slotted drawers or individual sleeves which hold the unit dose medications. All dosage forms, tablets, liquids or syringes can be dispensed. Pharmacy technicians are responsible for loading the cabinets and ensuring they contain adequate supplies of each medication for a 24-hour period. When a medication is needed, the nurse will log onto the system with a confidential password, call up a specific patient profile, and select the needed medications, which will then be dispensed automatically to the nurse. The identity of the nurse, medication dose, and time is recorded within the system. The nurse also documents the administration on the MAR. If an immediate dose of medication is needed, or if a new medication order has not yet been entered into the computer, an over-ride function can be utilized to access the needed medications (Novek et al., 2000).

A review of the literature identified four research articles on ADS that related specifically to nursing practice. Two of the studies found that the ADS improve the efficiency of medication administration (Borel & Rascati, 1995; Shirley, 1999), while the study by Guerrero, Nickman and Jorgenson (1996) did not find that the ADS decreased

the proportion of time nurses spent on medication related activities, but did measure an increased efficiency with which pharmacists used their time for patient care related activities. In a study by Shirley (1999), it was found that the percentage of medications administered as scheduled was significantly greater following implementation of the system. Medications were found 2.3 times more likely to be administered as scheduled (more timely). The clinical implications of having medications administered on time may vary depending on the nursing unit. Having pain medications administered on time could be a quality of life issue on a hospice or palliative care unit (Shirley, 1999).

In the observational study by Borel and Rascati (1995), not only did the researchers find that the ADS improved efficiency of medication administration, they also found a decrease in the medication error rate from 17% prior to implementation of ADS to 10% two months after the implementation of ADS. In both phases of the study, most of the errors were wrong-time errors. In addition, the most common complaint in this study by nurses using the ADS was the need to line up at the machine at busy times, sometimes removing medications earlier than scheduled to avoid the wait, or removing more than one patient's medications while at the machine for efficiency purposes, both activities being a potential source of error.

A research study by Novek et al. (2000) looked at nurses' perceptions of the reliability of ADS. They found that nurses were generally distrustful of ADS and unconvinced that it reduced medication errors due to a variety of factors. Factors associated with this attitude included: down time associated with "crashes", time for required maintenance, time required to troubleshoot problems, long delays for prescriptions to be entered into the computer by pharmacy, the need to record floor stock

medications on both the computer and the MAR, a time window of only one hour before to one hour after the scheduled administration time to retrieve medication from the system (causing nurses to override built in controls), miscommunication or a discrepancy at either end of the system (pharmacy at order entry and nursing at retrieval end causing implications for the other department, along with stress and frustration), and, lastly, unrealistic impressions and expectations of the automated system from hospital administrators and patient care managers (Novek et al., 2000).

To summarize, there is not one outstanding safety system or practice that has been identified as best to prevent medication errors in the acute care setting. The literature review suggests a combination of systems (BPOC, CPOE, “smart pumps”, ADS) along with vigilance and communication between healthcare providers (physicians, nurses, pharmacists) may have the largest impact on reducing medication errors.

## **2.4 Nurses’ Reporting of Errors**

Because of the large number of medications administered in an acute care hospital that have the potential for serious error, it is essential for institutions to have an effective medication administration error (MAE) reporting system (Wakefield et al., 1999). In most hospitals, this is a non-automated and voluntary process. When a MAE occurs it is essential that it is identified, reported, and then analyzed to determine the source and cause of the error from both a risk-management and continuous quality improvement perspective (Wakefield et al., 1999). Previous research has shown that many MAEs are not recognized or reported (Allan & Barker, 1990; Wakefield et al., 1996). Generally, the MAE reporting process involves four basic steps that include: recognition that a MAE has occurred; assessment that there is a need for reporting; preparation of an

incident report; and follow-up by the administrative party receiving the report (Wakefield et al., 1999). Though this process appears straightforward, numerous factors may prevent reporting. When MAEs are not reported, the chance to avoid future preventable errors is greatly decreased (Wakefield et al., 1999). A review of the literature focused on nurses' reporting of medication errors and identified 12 research studies.

An initial study by Wakefield, Wakefield, Uden-Holman and Blegan in 1996 looked at perceived barriers in reporting MAEs. They surveyed 1,384 nurses in 24 acute care hospitals in Iowa. The survey instrument contained 16 statements that reflected reasons why medication errors may not be reported. Participants were asked to indicate their level of agreement using a 6-point Likert-type scale. Individual items with the highest mean value (strongest agreement) included: "No positive feedback for passing medications correctly" (mean = 4.2); "Could be blamed if something happens to the patient" (mean = 4.0); "When medication errors occur the focus is on the individual rather than the system" (mean = 3.9); "Nurses may not think the error is important enough to report" (mean = 3.65); "Nurses believe other nurses will think they are incompetent" (mean = 3.64) and, lastly, "Nurses fear adverse consequences from reporting medications errors (mean = 3.59).

In 1999, Wakefield et al. conducted a second study with the purpose of confirming four factors that described reasons MAEs may not be reported and to analyze the resulting subscale at the nursing unit level. Using a nonrandom, convenience sample of nurses from 29 of Iowa's acute care hospitals, a total of 1,428 usable surveys were returned. A confirmatory factor analysis supported a four-factor model of reasons why MAEs may not be reported: (a) administrative response; (b) fear; (c) disagreement over

an error; and (d) reporting effort. In addition, the mean subscale values were again found in the central range of the scale, indicating neither strong agreement nor disagreement with a particular set of reasons for why MAEs may not be reported, though overall there was a somewhat higher level of agreement with the Fear and Administrative Response subscales. Supervisors demonstrated a much larger range of subscale values as compared to staff nurses. More importantly, staff and supervisor nurses working on the same unit varied considerably across the four subscales. If there is disagreement between nurses and staff over what constitutes an error, or if supervisor nurses demonstrate a lack of understanding of their staff's perceptions, then interventions to encourage MAE reporting may not work (Wakefield et al., 1999).

In 2001, Wakefield et al. studied medication error reporting in relation to organizational culture and continuous quality improvement (CQI). A major principle of CQI programs is creating an organizational culture that emphasizes employee empowerment, improving work processes and systems, rather than focusing on individual errors. Based on the responses of nurses from the 1994 survey and 1996 follow up, some of the reasons for MAEs not being reported included, fear of blame being placed on individuals, lack of positive response for correct medication administration, and fear of being labeled incompetent. These results suggest potential changes could improve the MAE reporting system by development of an organizational culture opposed to laying blame and education about the importance of analyzing patterns of MAE, rather than individual MAEs, to identify system problems (Wakefield et al., 2001). The 2001 study was cross-sectional, utilizing a convenience sample of nurses from the six Midwest hospitals who responded to the previous MAE Reporting Survey in 1996, resulting in 292

surveys for analysis. The nurses were surveyed using measures of organizational culture and CQI implementation. This data were combined with previously collected data on perceptions of MAE reporting. Findings demonstrated that a group-oriented culture (focused on norms and values associated with affiliation and trust) had a significant correlation with CQI implementation. Hierarchical culture (focused on control, rules, stability, and conservative, cautious leadership) and Rational culture (controlling productivity and efficiency) were negatively correlated with CQI implementation. The researchers also found that a group-oriented culture with a greater extent of CQI implementation were positively associated with the estimated overall percentage of MAEs reported. In addition, higher barriers to MAE reporting were associated with lower perceived reporting rates (Wakefield et al., 2001).

In 1998, a qualitative study to identify nurses' beliefs about medication incident reporting was published by Walker and Lowe from Queensland, Australia. Data were collected from 43 nurses using a self-report questionnaire, along with focus group discussions. Results of the questionnaire indicated that nurses were more likely to report a medication error when they believed patient safety might have been compromised. The nurses also indicated they would be less likely to complete an incident report for errors of documentation or for minor variations from the prescription. The focus group discussions identified three major themes to include: "self-preservation", "it depends", and "concerning harm to the patient". The first theme "self preservation" related to past experiences or anticipation of getting into trouble. Comments included: "it was the way you were treated when you reported an incident in the past... people don't like putting their names on the form" (Walker & Lowe, 1998, p. 99). The second theme, "it

depends”, related to the nurses’ analysis of the clinical situation and what part the medication error played in the situation. Any of the ‘five rights’, wrong drug, wrong route, wrong person, or wrong dose exerted a strong influence on reporting, with wrong time having the weakest influence on reporting being categorized as “it depends”. Comments included: “A drug given an hour late is not really a problem...you make a judgment about what you report and when” (Walker & Lowe, 1998, p. 99). The last theme, “concerning harm to the patient” was not commented on as frequently as the first two themes, but the conversation about this theme was very direct and clear cut, emerging very early in focus group discussions. Comments included: “If the patient is affected then that is all that counts...If it affects the patient...Something that constitutes an unsafe situation for the patient” (Walker & Lowe, 1998, p. 100). It is important to note that the findings and themes from this qualitative study are very similar to the four factors identified in the 1996 Wakefield et al. study on barriers of reporting MAEs and the 1999 Wakefield et al. confirmatory follow-up study, understanding why MAE may not be reported.

In 2000, Antonow, Smith, and Silver conducted a survey on medication error (ME) reporting of 72 RNs from one inpatient unit of a pediatric referral hospital. The survey was conducted during mandatory skills sessions and then was compared to written incident reports (IRs) from the previous six months. The RNs described 177 errors, as compared to 51 IRs for MEs. It was found that there was a decreased likelihood of IRs for errors of medication ordering, as compared to errors of medication administration. In addition, more IRs were written for wrong medication and dose errors. The strongest association observed was related to errors that prevented medications from reaching the



patient, as these errors were less likely to be reported. The researchers also concluded that anonymous ME surveys completed at mandatory education activities could enhance error reporting over traditional written IRs. The survey data could then be used for monitoring of the medication administration process and improvements in the medication system (Antonow et al., 2000).

Stratton, Blegan, Pepper, and Vaughn (2004) conducted a pilot study looking at medication error reporting by pediatric and adult hospital nurses, with this article focusing on pediatric nurses. They used a convenience sample of 57 pediatric and 227 adult health nurses (40% response rate). The researchers identified that pediatric nurses indicated a higher rate of medication errors being reported (67%) as compared to adult health nurses (57%). In addition, pediatric nurses also identified interruptions or distractions and RN to patient ratios as the foremost reasons errors occurred. Reasons for not reporting errors included fear of reprimand and administration focus on the person, rather than the system.

In an effort to review the quality of patient care in acute care settings, Blegan et al. (2004) developed a study to review MAEs, patient falls, and occupational injuries. Results of this survey were based on 1,105 RNs from 25 hospitals nationwide. The researchers found that greater than 90% of the nurses indicated they should report MAEs involving the wrong patient, wrong dose, wrong drug, wrong route, medication not ordered, and medications in which the patient was allergic. These categories are very similar to those identified in the qualitative study by Walker and Lowe (1998). In addition, 84% of the nurses agreed wrong time errors, omitted medications, or medications administered after they had been discontinued should also be reported. Only

36% of nurses felt that near misses should be reported which would correspond to the results found in the aforementioned study by Antonow et al. (2000). These results may also reflect that attention to near misses is quite recent. Estimated MAE reporting rates varied widely across nurse participants, the situation or incident, as well as within the type of nursing unit the respondent worked. Nurses felt errors related to intravenous medications were reported at the highest rate (51%). There was general agreement across all units and nurses that MAEs were not reported due to personal fears (e.g. blame, incompetence) and administrative response (e.g. overreaction, focus on person rather than system, loss of license). These results correspond to the findings by Wakefield et al. (1996), Wakefield et al. (1999), and Walker and Lowe (1998).

Evans et al. (2006) published a collaborative study surveying both doctors and nurses regarding attitudes and barriers to incident reporting. These researchers found that most doctors and nurses were aware of an incident reporting system, but that more nurses than doctors knew how to access a report, had ever completed a report, and knew what to do with the completed report. Incident reports were more likely to be filled out on witnessed errors, those associated with immediate outcomes, or those requiring corrective treatment. Near misses and situations that occur over a period of time (e.g. inadequate prophylaxis to prevent deep vein thrombosis) were much less likely to be reported. Both doctors and nurses believed incident reports should be completed, with nurses in higher agreement. Doctors felt incident reporting could be improved if clarification was given as to which incidents to report, simplifying the process, and giving feedback to the reporter (Evans et al., 2006).

In response to the Institute of Medicine's first report and a hospital wide quality initiative, Potylycki et al. (2006) developed and conducted a baseline survey to identify underlying practices and attitudes on medication errors and disciplinary actions. The findings from this survey were then utilized by the hospital taskforce to develop a Non-punitive Patient Safety Policy (NPSP) and related interactive workshop. Following implementation of the new policy within the institution and staff attendance at the associated workshop, a post-survey was conducted, along with a comparative analysis. Staff members included in the survey were all individuals who prepared, administered, transcribed, educated, or oversaw medication administration, including over 600 nurses. This study took place over a three-year period. The researchers found that the staff identified disciplinary action as the primary barrier to reporting medication errors and that a medication error was qualified by the severity of its outcome, those with more serious outcomes were more likely to be reported. The researchers also found that staff attending the workshop were more likely to believe that near misses are as important to prevent as actual errors, the review of reports are to assure patient safety, they were more comfortable reporting an error without fear of reprisal, would be more likely to report an error made by a co-worker, could more openly communicate their opinions on patient care practices, and if they observed an error would be more likely to report it versus discussing the error with the person who committed it (Potylycki et al., 2006).

Also in response to the IOM's call for non-punitive approaches to medication error identification, Wolf and Serembus (2004) designed a study to identify the reactions of managers and other personnel intimately involved with error reporting and to find out the experiences of individuals who have made the mistakes. Data were obtained through

a mailed self-report survey examining serious medication errors using open and closed ended questions. The sample included 208 nurses, 112 pharmacists, and 82 physicians, though this was only a 6% response rate. Health care providers ( $n = 3,000$ ) from each category had been invited to participate through a systemic random sampling technique, with names being provided by the State Boards of Medicine, Nursing, and Pharmacy in the state of Pennsylvania. The researchers found that attending physicians and nurse managers were notified most often following an error. Of the respondents, 50% described no consequences involving administrators or managers following an error, though the researchers further uncovered that many managers and administrators acted negatively and aggressively after an incident. Some staff were interrogated by the director of nursing and experienced the irate and targeted behavior of a physician. Furthermore, trust in physicians was shaken when they denied having prescribed the medications. Some staff were made to feel embarrassed or humiliated; others were threatened or blamed, while some received disciplinary points or a note in their professional record. Following a medication error, health care providers experienced more non-supportive actions than supportive actions (Wolf & Serembus, 2004).

Briefly, a 2006 study by Chiang and Pepper sought to identify Taiwanese nurses' perceptions of barriers to reporting medication errors and to examine the relationship between the barriers, cultural factors, and work environment in Taiwan. The researchers collected survey data from a total of 597 nurses. The findings showed that the major perceived barrier to reporting medication errors was fear (e.g. blame, incompetence, reporting consequence) followed by administrative barriers (e.g. no positive feedback, focus on individual). The researchers also found the more power hierarchy and

face-saving concern the nurses agreed on (e.g. respect for tradition and authority, group harmony), the more barriers they perceived. The relationship between barriers and work environment (e.g. quality management, peer relations, working conditions) was found to be negative and weak (Chiang & Pepper, 2006).

Lastly, a 2007 study by Sanghera, Franklin, and Dhillon looked at the beliefs and attitudes of health care professionals on the causes and reporting of medication errors in a United Kingdom intensive care unit. Medication errors were identified through the unit pharmacist or through the incident reporting system. The researchers utilized semi-structured interviews with a total of 13 staff members who had been involved with 12 medication errors. The staff were interviewed within 96 hours of the error. The study findings related to reporting of errors included: not being aware that an error had occurred; the process of reporting was too detailed, time consuming and confusing; there was no benefit to reporting; and fear of consequences. The majority of staff perceived there to be some benefits to reporting and reasons included: learning from mistakes, reduced chance of litigation, accountability, prevention of future errors, improving practice, and reflection on practice. One staff member from a different culture (not identified in article) verbalized that the process of reporting errors was strange. Staff from other cultures raised cultural differences for not reporting, though the differences were not identified in the article (Sanghera et al., 2007). As the nursing shortage continues and becomes more serious throughout the U.S., the recruiting of nurses from other cultures may increase in an attempt to fill the empty positions. Due to this practice, it will become even more important to identify cultural similarities and differences

among nurses within the work environment, so that patient safety will not be compromised.

In summary, previous research supports that many errors are not reported (Allan & Barker, 1990; Wakefield et al., 1996). Research also supports the idea that there are many different factors as to why this occurs. Two major themes that are found to reoccur in the literature regarding reporting include „fear’ and „administrative response’. Other central issues identified include: seriousness of the error, disagreement over whether an error had occurred, and the reporting process itself. It is essential for all types of medication errors to be identified, reported, and analyzed so that the source and cause of the error can be determined, in order to prevent future errors keeping our acute care population safe.

## **2.5 Injury Prevention Model – Haddon Matrix**

The way we think about injury determines how effective we will be in reducing the burden of injury in America (Christoffel & Gallagher, 2006). Over the past several decades, the focus on injury has shifted from both a biological and behavioral perspective on the individual to an emphasis on the environmental context within which the injury occurs (Christoffel & Gallagher, 2006). Also, there has been a conceptual shift from a single-cause explanation of injury to a more multi-faceted approach. In addition, prevention of injury is now not only the responsibility of the public health community, but involves the collaboration of many disciplines (Christoffel & Gallagher, 2006). Lastly, modern injury prevention, which evolved in the 20<sup>th</sup> century, identifies that individuals are often in a poor position to recognize and control injury risks (Christoffel & Gallagher, 2006). In terms of medication administration errors, these errors are

thought of in the acute care setting of a hospital as a systems issue, caused by a multitude of factors, involving physicians, pharmacists, nurses and patients, with patients often unable to protect themselves from injury due to illness.

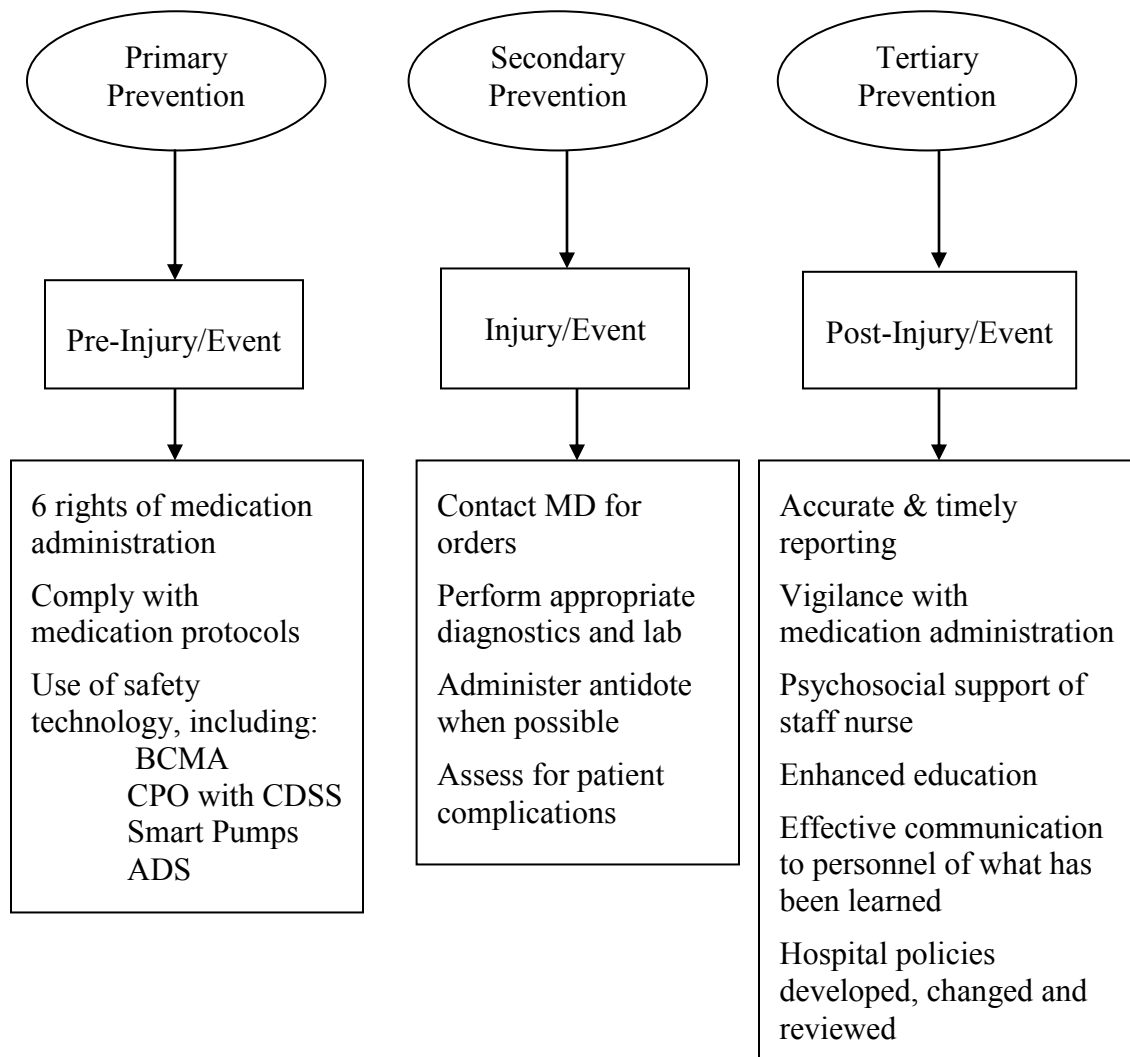
Gordon, an epidemiologist at Harvard in the 19<sup>th</sup> century, described “injuries” as being “the result of at least three sources, the host, the agent and the environment in which host and agent find themselves” (Gordon in Christoffel & Gallagher, 2006, p. 28). In terms of injury, specifically a medication error, the host would be the nurse administering the medication, the agent would be the wrong medication due to labeling, and the environment would be chaotic at a change of shift, with the nurse being distracted and interrupted several times for questions.

William Haddon expanded upon Gordon’s epidemiologic triad by identifying that host, agent and environment could be further analyzed in terms of the pre-event (injury) phase, the event (injury) phase, and post-event (injury) phase (Christoffel & Gallagher, 2006). Primary prevention approaches would be implemented in the pre-event phase, secondary prevention during the event phase, and a focus on tertiary prevention in the post-event phase. Again in terms of medication errors, primary interventions to prevent errors would include but would not be limited to: use of the six rights of medication administration to include the right medication, dose, route, time, patient, and documentation, and use of safety technology systems in the acute care setting, such as bar code medication administration, computerized physician order entry with clinical decision support systems, smart infusion pumps, and automated dispensing systems. Once a medication error has occurred, the aim of secondary prevention measures would be to respond appropriately to and implement effective measures to minimize potential

physical or mental injury. For example, if an overdose of a continuous infusion of the anticoagulant heparin occurred, the nurse would respond by: immediately identifying and contacting the appropriate physician for orders; drawing the appropriate blood work, in this situation a partial thromboplastin time and platelet count; administering the antidote for heparin, protamine sulfate, if indicated; and watching the client for possible side effects or adverse reactions (overt bleeding, severe headache, abdominal pain) over an appropriate period of time. Post-event, tertiary prevention measures directed toward the patient would include physical and mental support as needed, along with appropriate rehabilitation efforts if indicated. Tertiary prevention measures directed towards nursing would include: accurate and timely reporting of the medication error by the nurse, increased vigilance with medication administration, psychosocial support of the staff nurse in a non-punitive environment, enhanced medication education if warranted, along with effective communication to personnel of what has been learned from medication error reporting within the institution. In addition, hospital policies related to medication administration may need to be reviewed and changed (See Figure 1).



**Figure 1-2** Prevention of Medication Errors by Stages of Prevention



Haddon continued to extend his conceptualization of injury by his development of ten strategic countermeasures to address injury control. These measures are used to control, modify or interrupt injury. Generally, a mixed preventive approach is used with priority and emphasis on the measures that will most effectively reduce injury. These approaches are then incorporated into all three phases of the injury-event sequence. The ten countermeasures incorporated with examples related to medication error prevention include:

1. Prevent the creation of the hazard by banning the manufacture and sale of inherently unsafe products or prohibiting inherently unsafe practices (e.g., utilize computerized physician order entry with decision support system).
2. Reduce the amount of energy contained in the hazard (e.g., package potent medications in smaller, safer amounts).
3. Prevent the release of the hazard that already exists ( e.g. remove intravenous potassium solutions from nursing shelves, highlight awareness to look alike or sound alike medications, check insulin and anticoagulants with a second nurse).
4. Modify the rate or spatial distribution of the hazard (e.g. utilize smart infusion pumps, promote use of single patient rooms).
5. Separate in time or space, the hazard from that to be protected (e.g., place medication preparation rooms in low traffic areas, utilize signs that state nurses should not be disturbed during preparation and administration of medications).
6. Separate the hazards from that which is to be protected by a material barrier (e.g., utilize barcode medication administration systems or automated delivery systems).
7. Modify relevant basic qualities of the hazard (e.g., improve packaging of single dose medications with bold, clear lettering).
8. Make what is to be protected more resistant to damage from the hazard (e.g., teach capable patients to question the nurse about medications they are receiving).

9. Begin to counter the damage already done by the hazard (e.g., respond appropriately to a known medication error versus cover-up).
10. Stabilize, repair, and rehabilitate the object of damage (e.g., provide appropriate and continuing care to the injured patient at no cost if warranted) (Christoffel & Gallagher, 2006).

The Haddon Matrix and ten countermeasures have been utilized by a broad range of disciplines and injury prevention experts over the years. Although the model was developed in context of injury control, it is applicable to any health problem (Runyon, 2003). Haddon (1972) himself utilized these concepts with motor vehicle safety. Although this model has never been associated with the problem of medication administration errors in the acute care setting prior to this writing, it has been applied to such areas as playground falls, firearm injury, ski injuries, domestic violence, child abuse, and cancer associated with smoking, to name just a few, demonstrating its usefulness to both research and prevention planning.

## **2.6 Summary**

In summary, the purpose of this chapter was to examine the literature on nurses' perceptions of medication errors, contributing factors to medication errors, review safety systems available to acute care settings to potentially decrease medication errors, and to review the literature on nurses reporting of medication errors. Though research has been done on nurses' perceptions of medication errors, methodological issues have been identified through this review. Specific issues included: convenience samples, small sample size, lack of representativeness of samples, lack of reliability testing of surveys, low survey return rates, and lack of conceptual/theoretical framework for the studies.

Another important issue regarding this research relates to the age and dates of the research. Four of the seven studies on medication administration errors were published from 1995 through 1999. Since the year 2000, when the IOM report was issued, many changes have or are currently taking place in the health care arena, specifically in the acute care setting to make patient care safer. The National Patient Safety Goals are now in place, with several of the goals dealing specifically with safer medication administration practices. In addition, the use of technology such as computer assisted order entry, bar-coding of medications, computerized robotics, and smart pump infusion technology has begun to alter the way medication administration is being performed on the nursing units and at the patient bedside by nurses. These changes, thought to be positive could potentially bring along a whole new set of problems related to the medication administration process.

In addition, eight factors contributing to medication errors have been reviewed to include: mathematical skills of nurses, knowledge of medications, length of nursing experience, length of nursing shifts, workload and staffing levels, adherence to policies and procedures, distractions and interruptions, along with quality of prescriptions. A review and evaluation of this literature makes it clear that identifying causation is extremely difficult due to the many variables identified, along with confounding factors and methodological issues associated with this research. Also compounding this issue is the level of error reporting by nurses. Reporting has been identified to be quite low due to several reasons identified as: lack of recognition or disagreement over whether an error has occurred by many nurses, an ineffective reporting system in many institutions, and the fear of administrative response.

Based on the statistics related to injuries and deaths due to medication errors occurring in the acute care systems of the U.S., along with the many methodological issues that have been identified through this review and associated with the nursing research related to medication errors, it is essential that a strong methodological research study encompassing nurses' perceptions of medications errors, contributing factors, and reporting of errors be carried out. This will allow the true causes and factors of the medication error problem to be identified and analyzed so that effective strategies can be put in place at the unit, hospital and national level to keep patient populations safe.

## **Chapter 3**

### **Methods**

This chapter describes the design, development and implementation of the survey instrument to assess nurses' perceptions of medication errors. The sections included in this chapter are: Selection of Participants, Instrument Development, Instrument Testing, Procedures, and Data Analysis.

#### **3.1 Selection of Participants**

The participants for this study were registered nurses from across the United States who were members of the American Nurses Association in 2008. This study included registered nurses who graduated with a diploma, associate, bachelor's degree, or master's degree, and were actively working. From a membership of nearly 168,000 nurses, a random sample of 5,000 names was purchased from American List Council (ALC). ALC has been ranked number one in its data card quality for validity of lists (K.S. Fischette, personal communication, August 8, 2008). The purchased list contained the names and addresses of nurses from the 48 contiguous states (i.e. excludes Hawaii and Alaska) who were members of this organization. From the 5,000 names, 800 participants were randomly selected to participate by taking every sixth name across the file. An *a priori* power analysis was conducted to minimize a Type II error. The sample

size required for this study was calculated to be 384 based on a 5% sampling error with a 50/50 split and a 95% confidence interval (Dillman, 2000, p. 207). Based on the traditionally poor response rates (20% to 44%) of nurses (Balas, et al., 2004; Mayo & Duncan, 2004; Ulanimo et al., 2007), 800 surveys were mailed with the intention of obtaining greater than a 50% return rate.

### **3.2 Instrument Development**

A four page instrument was developed to assess nurses' perceptions of medication errors (See Appendix A). The instrument was designed following a comprehensive review of the literature, along with use of the "Haddon Matrix" by William Haddon (Christoffel & Gallagher, 2006). This matrix includes the three phases of injury (pre event, event, and post event) along with the epidemiological factors (human, agent, physical environment, and sociocultural environment). For thoroughness, each question developed for the current survey research was assessed for fit within the Haddon Matrix (See Table 5). In addition, a variety of surveys on medication errors and reporting were reviewed for critical ideas and content (Mayo & Duncan, 2004; Modak, Sexton, Lux, Heimreich & Thomas, 2007; Wakefield et al., 1998).

**Table 5-3***Haddon Matrix Medication Errors*

	Human Factors	Agent or Vehicle	Physical Environment	Sociocultural Environment
<b>Phases</b>				
Pre-event	1A, 1B, 1G, 1H, 1J, 1K, 1L	1I	1C, 1E, 1F 6A, 6B, 6C, 6D	1D  4B, 4F, 4G
	1, 2, 3, 4, 5, 6, 7, 8, 11, 12, 13		9, 10, 15, 16, 17, 18	14
<b>Event</b>				
	2A, 2B			
<b>Post-event</b>				
	3A, 3B, 3C, 3D, 3F, 3G	4A	3E	2C  3H
	4C, 4E			4D  5A, 5B, 5C

In the current study the investigator developed seven areas of focus. The sections included:

1. Contributing factors to medication errors.
2. Experiences with medication errors.
3. Barriers to reporting medication errors.
4. Factors increasing likelihood of reporting medication errors.
5. Communication of medication errors.
6. Helpfulness of medication administration technology.
7. Nurse demographics and characteristics.



In part one of the survey, questions A through M asked the participant to rate how important each individual factor is in contributing to medication errors. Factors that were included are: dose calculation, depth of medication knowledge, interruptions during the medication process, usefulness of policies and procedures related to medication administration, nursing workload, patient acuity, overtime hours per day and week, incomplete medication orders, lack of clinical expertise in the area one is working, newness to nursing practice, hostile or tense feelings during medication administration, and, lastly, a blank area to write in other barriers deemed important by the nurse which had not been included on the list.

Part two of the survey addressed nurses' experience with medication errors. The focus of questions A through C included: the number of medication errors made by the nurse or a colleague that resulted in harm to a patient over the past year, along with the number of medication errors committed over the past year that did not harm the patient. The last question in this section evaluated the number of medication errors that were reported in the past 12 months, those that caused harm to a patient, and the number of errors reported that did not cause harm.

Part three of the survey addressed nurses' perceptions regarding barriers to reporting medication errors. Statements A through I included: focus on the individual rather than the system, thinking colleagues will feel the nurse is incompetent, feeling the error is not important enough to report, fear of blame, finding reporting to be too detailed or time consuming, afraid of a reprimand, afraid of consequences, and feeling a near miss is not an error. A blank area was also included for the nurse to write in other barriers felt to be important to error reporting.

Part four included factors which might increase the likelihood of medication error reporting. Statements A through H included: violation of any of the “five rights” of medication administration, anonymous reporting process, safety of the patient has been compromised, benefits of reporting are identified by nurse, no fear of retaliation in the workplace, positive relationship with supervisor, and positive relationship with physicians the nurse works with on the unit. A blank area was included for the nurse to write in other important factors not identified in the statement list.

Part five included three statements associated with communication of medication errors. These were: reporting the medication error to the patient, reporting the error to a family member if appropriate, and use of medication error report cards for hospitals which are then published for the public to review.

Part six of the survey assessed how helpful nurses felt medication administration technology had been in decreasing medication errors. Technology included in questions A through D are: bar coded medication administration, computerized physician order entry, automated medication dispensing, and smart infusion pumps.

Lastly, section seven included nurse demographics and background characteristics. Question 1 through 17 included: gender, ethnic background, age, highest level of education, if national certification in a clinical specialty has been attained, years of clinical experience, time since attending pharmacology continuing education, how pharmacology was taught in the nurse’s undergraduate program, work schedule, shift worked along with rotation of shift, time since mathematical skills have been formally tested, frequency of working over 12 hours in one day, if the nurse would feel safe being

cared for in the hospital in which she or he works, if nurse works in same practice setting, size of hospital, and type of unit or area where she or he works.

Most items on the survey were closed format, featuring Likert-type responses. All scales throughout the survey were bipolar, utilizing several responses which included: “Never to Always”, “Major Barrier to Not a Barrier”, “Highly Likely to Highly Unlikely”, “Strongly Agree to Strongly Disagree”, and “Very Helpful to Not Helpful at All”. In addition, numerous questions asked the respondent to check or circle an appropriate response. Several questions required the respondent to write in a numerical number. Lastly, several questions had the option of writing in an “other” option.

### **3.3 Instrument Testing**

#### **3.3.1 Validity**

Face validity of the instrument was established via a comprehensive review of the literature in the area of medication administration errors specifically focused on nursing in the acute care setting. The following databases were used for all searches: CINAHL, Academic Search Premier, Alternate HealthWatch, Health Source: Nursing/Academic Edition, Medline, and Sportdiscus. Face validity was also established by reviewing previously published survey instruments on medication errors and reporting. To establish content validity, the survey was sent to an expert panel ( $n = 4$ ) of reviewers that had strong expertise in survey research and medication error knowledge based on their research and publication record. Minor changes were made to the survey based on the comments of the experts.

### **3.3.2 Reliability**

A convenience sample of nine registered nurses working in the Toledo area was utilized for pilot testing and stability reliability. The instrument was given to the nurses on two separate occasions, two weeks apart. Pearson product moment correlation coefficients were calculated based on the matched responses. Results are shown in Table 6. Internal consistency reliability was tested using Cronbach alpha on appropriate sections of all returned surveys. The results are also shown in Table 6.

**Table 6-3***Stability Reliability and Consistency Reliability of Questionnaire Components*

Item or Subscale	Number of Items	Test – Retest*	Cronbach Alpha**
Causes of Medication Errors	12	.78	.85
Barriers to Reporting	8	.77	.87
Factors likely to Increase Reporting	7	.79	.84
Communication of Errors	3	.99	.77
Technology Utilized to Decrease Errors	4	.63	.75

*Note: \*N = 9 \*\*N = 341***3.4 Data Collection**

Approval was obtained from the University of Toledo's Human Subjects Research Review committee. A three-wave mailing was then conducted. The first wave mailing consisted of a hand signed cover letter explaining the purpose of the study and to assure confidentiality. Additionally, a one dollar bill was sent as an incentive to return the completed survey. The instrument was printed on blue paper and envelopes were postmarked with colorful stamps (Ulrich, et al., 2005; Edwards et al., 2002; King, Pealer & Bernard, 2001). To maximize the response rate, two weeks after the first mailing, a second cover letter was sent to non-respondents, along with another copy of the questionnaire, and a first class postage-paid return envelope. The third wave mailing consisted of a postcard, the same color as the survey to remind participants to complete the survey if they had not already done so (Edwards et al., 2002; King, Pealer & Bernard, 2001). Non-deliverable surveys and surveys returned non-answered were replaced as the proportion exceeded 5%.

### 3.5 Data Analysis

Analysis of data was done using SPSS 17.0 statistical software application for Windows. An *a priori* alpha level was set at 0.05 to reduce the chances of a type I error. Descriptive statistics such as frequencies, range of frequencies, percentages, means, and standard deviations was used to describe demographic data of respondents. In addition, independent t-tests were used for hypotheses (1.1, 1.2, 1.5, 1.6, 1.9, 1.10, 1.11, 1.12, 1.15, 1.16, 1.17, 1.18, 1.21, 1.22, 2.2, 2.5, 2.7, 3.2, 3.5, 3.7 ) Also, for those hypotheses having more than two groups (1.2, 1.4, 1.13, 1.14, 1.19, 1.20, 2.1, 2.3, 2.4, 2.6, 3.1 3.3, 3.4, 3.6), analysis of variance (ANOVA) was calculated with appropriate post-hoc tests to determine if there were significant differences between the means. Lastly, percentages were used to calculate hypotheses (4.1, 4.2, 4.3, 5.1, 5.2, 5.3, 5.4).

## **Chapter 4**

### **Results**

In this chapter, the descriptive and inferential statistical analyses of the research data are explained. The sections in this chapter include: Response Rate; Demographics and Background Characteristics of Respondents; Primary Causes of Medication Errors; Nurses Experience with Medication Errors; Barriers to Reporting Medication Errors; Factors Likely to Increase Reporting of Medication Errors; Communication of Medication Errors; Perception of Medication Technology Associated with Decreasing Medication Errors; Feelings of Safety Among Nurses; Hypotheses Testing; and Summary of Results.

#### **4.1 Response Rate**

Surveys were mailed to 800 randomly selected registered nurses throughout the coterminous United States. At the time of the study, the respondent nurses were current members of the American Nurses Association. Participation was voluntary and those not wishing to participate did not return the survey.

Out of 800 surveys, 84 were undeliverable and 27 of the surveys were returned but not useable due to various reasons, such as the respondent was not currently practicing as a staff nurse, not currently working as a nurse, not a registered nurse, not a

nurse, or retired. Of the remaining 689 potential respondents 341 returned the surveys for a response rate of 49% (341/689).

#### **4.2 Demographics and Background Characteristics of Respondents**

The demographic characteristics of the respondents are shown in Table 7. Of the 341 respondents, the majority were female 317 (93%). The age of the nurses ranged between 25 and 75 years ( $M = 48.49$ ;  $SD = 10.27$ ). A plurality of nurses completing the survey were between the ages of 50 and 59 (41.1%). An overwhelming majority of the nurses were White (81.8%).

The majority of the nurses (61%) responding held an advanced degree, such as a master's degree in nursing, a doctorate, or a master's degree in a related field. The majority (55.1%) of the nurses held national certification in the specialty in which they worked. Years of clinical experience ranged from less than one year to 49 years of experience, with a mean of 20.0 years ( $SD = 11.8$ ). Slightly more than two-thirds (69.8%) of the nurses had greater than ten years of nursing experience. The majority of nurses responding (85.9%) worked full time. Slightly more than three-fourths (78%) of the nurses worked in or were associated with a hospital setting. Approximately one-third (31.9%) of the nurses were working over 12 hours in one day at least one to two times per two week period, and up to as much as five or more times in that same time period. Most nurses (74.2%) consistently worked in the same clinical practice setting when they were at work. Of the nurses who worked in the hospital setting, the most common positions included nurses from medical-surgical areas (21.7%), psychiatry (9.1%), adult intensive care (8.8%), and step-down areas (4.7%).



In regards to undergraduate and continuing education, a majority of nurses (61.9%) participated in formal pharmacology courses while pursuing their undergraduate degrees. The majority of nurses (51%) reported having attended some type of continuing education in pharmacology within the past year. Approximately one-half of all responding nurses (49.9%), reported they had never had their mathematical skills tested since becoming a nurse or it was more than five years since having these skills tested.

**Table 7-4**  
*Nurse Demographics and Characteristics*

Item	Total N	% of N
Gender:		
Female	317	93.0
Male	23	6.7
Race/Ethnicity:		
African American	21	6.2
Hispanic	12	3.5
White	279	81.8
Asian / Pacific Islander	16	4.7
Native American / Alaskan Native	2	0.6
Other	3	0.9
Age:		
20-29	16	4.8
30-39	53	15.9
40-49	83	25.0
50-59	140	42.1
60+	40	11.9
Highest level of education:		
Diploma in Nursing (2 or 3 years)	14	4.1
Associate Degree in Nursing	24	7.0
Bachelor Degree in Nursing	94	27.6
Master Degree in Nursing	167	49.0
Doctoral Degree	18	5.3
Other	23	6.7
National Certification in Clinical specialty:		
Yes	188	55.1
No	146	42.8

<hr/> Years of clinical experience since graduation		
0-5	40	11.7
6-10	56	16.4
11-15	37	10.8
16-20	28	8.2
21-25	46	13.6
26-30	55	16.1
31-35	40	11.8
40+	31	9.3
<hr/>		
Years since attending any pharmacology continuing education:		
< 1 year	134	39.3
1 year	40	11.7
2 year	42	12.3
3 year	23	6.7
4 year	9	2.6
5 year	20	5.9
6 year	6	1.8
7 year	5	1.5
8 year	5	1.8
9 year	0	0.0
10 or more	55	16.1
<hr/>		
How pharmacology was taught in undergraduate nursing program:		
Formal pharmacology course	167	49.0
Pharmacology integrated throughout curriculum	123	36.1
Multiple	44	12.9
Other	6	1.8
<hr/>		
Work schedule:		
Full-time	293	85.9
Part-time	41	12.0
Per diem	4	1.2
Retired	2	0.6
<hr/>		
Shift currently working:		
12 hour shift day	45	13.2
12 hour shift night	18	5.3
Rotate 12 hour shift	9	2.6
8 hour shift day	166	48.7
8 hour shift evening	6	1.8
8 hour shift night	8	2.3
Rotate 8 hours day/eve	6	1.8
<hr/>		

Rotate 8 hours day/night	2	0.6
Other	73	21.4
<hr/>		
Time since mathematical skills have been formally tested (e.g. in-house continuing education, skills review):		
< 1 year	92	27.0
1-2 years	45	13.2
3-4 years	32	9.4
5 years or more	104	30.5
Never	66	19.4
<hr/>		
Frequency of working greater than 12 hours in one day:		
Never	185	54.3
1-2 times in 2 week period	83	24.3
3-4 times in 2 week period	18	5.3
5 or more times in 2 week period	8	2.3
Other	43	12.6
<hr/>		
Clinical work setting:		
Work in the same clinical practice setting	253	74.2
Work as part of the float pool	7	2.1
Work various hospitals and different floors (from an outside agency)	2	0.6
Work on a long-term assignment, several months or more (from an outside agency)	4	1.2
Other	61	17.9
<hr/>		
Size of the hospital currently working in:		
Fewer than 100 beds (small)	37	10.9
100-299 beds (medium)	88	25.8
300 plus beds (large)	141	41.3
Do not work in hospital	68	19.9
<hr/>		
Primary place of employment is outside the hospital setting:		
Extended Care facility	11	3.2
Office type setting	31	9.1
Community Health setting	28	8.2
Hospice	5	1.5
I do work in a hospital	147	43.1
Other	52	15.2
Multiple	8	2.3
<hr/>		

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If working in a hospital the type of unit/area most often worked:		
Medical	12	3.5
Surgical	18	5.3
Medical/Surgical	44	12.9
Step-down	16	4.7
Obstetrics	7	2.1
Pediatrics	12	3.5
Pediatric ICU	1	0.3
Neonatal ICU	5	1.5
Adult ICU	30	8.8
Psychiatric	31	9.1
Long term care unit within the hospital	4	1.2
Other	90	26.4

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*Note: N = varies 340 to 341 due to missing data.*

### 4.3 Primary Causes of Medication Errors

Respondents were asked to rate 12 primary causes of medication errors which were identified from the literature as: never, rarely, sometimes, most of the time, or always causing a medication error (See Table 8). The categories „never’ and „rarely’ were collapsed together, as were the categories of „most of the time’ and „always’ for final analyses. Rank ordering of the primary causes identified the following top five causes of medication errors: interruptions during medication pass (43.4%), short RN staffing (35.2%), nurses caring for high acuity patients (33.7%), nurses working more than 12 hours in one shift (24%), and nurse knowledge of medication being administered (22.9%).

**Table 8-4***Primary Causes of Medication Errors*

Item	Never / Rarely	Sometimes	Most / Always
	N (%)	N (%)	N (%)
Interruptions during medication pass.	37 (10.8)	154 (45.2)	148 (43.4)
Short RN staff.	72 (21.1)	148 (43.4)	120 (35.2)
Nurse caring for high acuity patients.	64 (18.8)	160 (46.9)	115 (33.7)
Nurse works more than 12 hours in one shift.	108 (31.7)	150 (44.0)	82 (24.0)
Nurse knowledge of medication being administered.	60 (17.6)	203 (59.5)	78 (22.9)
Incomplete medication order.	112 (32.8)	156 (45.7)	72 (21.1)
Nurse works more than 40 hours in one week.	117 (34.3)	162 (47.5)	62 (18.2)
Nurse has limited clinical knowledge.	118 (34.6)	169 (49.6)	54 (15.8)
Nurse must calculate the dose of the drug.	104 (30.5)	189 (55.4)	48 (14.0)
Nurse not familiar with unit environment.	130 (38.2)	166 (48.7)	42 (12.4)
Unclear policy and procedures regarding medication administration.	170 (49.8)	139 (40.8)	32 (9.4)
Hostile work environment.	197 (57.8)	107 (31.4)	31 (9.0)

*Note:* N = 341

#### 4.4 Nurses Experience with Medication Errors

Table 9 shows the nurses responses in regards to the number of medication errors that a nurse or a colleague made that resulted in harm to a patient. Three-fourths (74.5%) of nurses reported that they had not made a medication error in the past 12 months that resulted in harm to a patient. However, 12.6% reported they had made at least one error that had resulted in some type of harm to the patient. Eleven percent of nurses reported they had made two or more errors that had resulted in harm to a patient over a 12 month period. The highest number of medication errors causing harm to patients made by a nurse was six.

**Table 9-4**

*Nurses' Experience with Medication Errors over 12 Months*

	N (%)	N (%)	N (%)	N (%)
	0	1	2 or >	
<i>Caused Harm to patient</i>	254 (74.5)	43 (12.6)	38 (11.2)	
	0	1	2-3	4 or >
<i>Did Not Cause Harm to patient</i>	129 (37.8)	65 (19.1)	73 (21.4)	66 (19.4)

*Note:* N = varies 333 to 335 due to missing data.

In regards to medication errors that “did not cause harm” to the patient (See Table 9), 37.8% of nurses reported not having made a medication error in the past 12 months; 19% reported having made one medication error; while 21% reported making two or three errors over a 12 month period. Approximately one in five nurses reported making four or more errors that “did not cause harm” to a patient over a 12 month period. While,

6% of nurses reported making over ten errors that they perceived did not harm their patients.

Independent samples t-tests were used to determine if the number of medication errors, either those that caused harm to a patient or those that “caused no harm”, varied by selected variables, such as national certification, participation in pharmacology continuing education (within the past two years), how pharmacology was taught in the nurses undergraduate program (formal course or integrated), work schedule (full-time or not full-time), mathematical skills formally tested (within the past two years), and whether the nurse consistently practiced in the same clinical setting. Only two variables (consistent clinical practice setting and whether the nurse had worked over 12 hours in one day during a two week period) demonstrated statistically significant differences in the number of medication errors. There was a statistically significant difference in the number of self reported medication errors that “did not cause harm” to a patient between nurses who consistently worked in the same clinical practice setting and those who did not consistently work in the same clinical practice setting ( $t = -2.181, df = 317, p = .03$ ). The mean number of errors for those who consistently worked in the same practice setting was greater ( $M = 2.34; SD = 2.98$ ) than for those who did not work in the same practice setting ( $M = 1.49; SD = 2.65$ ). In addition, there was a statistically significant difference in both the number of medication errors that caused harm ( $t = -2.414, df = .218, p = .02$ ) to a patient and the number of medication errors that “did not cause harm” ( $t = -2.255, df = 286, p = .03$ ) to a patient based on whether the nurse had worked over 12 hours in one day over a two week period. Those nurses who had worked over 12 hours had a greater mean number for medication errors resulting in harm ( $M = .56; SD = 1.13$ )

compared to those who had not worked over 12 hours ( $M = .36$ ;  $SD = .84$ ). In regards to medication errors causing no harm, the mean for nurses not working over 12 hours ( $M = 2.11$ ;  $SD = 3.24$ ) was not significantly less than for those nurses working over 12 hours ( $M = 2.18$ ;  $SD = 2.53$ ).

Analysis of variance (ANOVA) was used to determine if there was a difference in the number of medication errors, either those that caused harm to a patient or those that “did not cause harm”, related to such variables as years of clinical experience (0 to 4 yrs., 5 to 9 yrs., 10 to 14 yrs., 15 to 19 yrs., 20 to 24 yrs., 25 to 29 yrs., 30 to 34 yrs., 35 to 39 yrs., 40 to 44 yrs., or >45 yrs.) and size of hospital (small, medium, large). Results of these analyses found that the number of medication errors did not differ in a statistically significant way for either variable.

The respondents’ level of education was not analyzed in relation to the number of medication errors. Of respondents, 61% ( $n = 208$ ) had a masters or doctoral degree, with a large majority of these nurses identifying themselves as advanced nurse practitioners. The majority of these advanced practice nurses would not currently be working as staff nurses in the hospital setting. This issue altered the sample size of useable nurses ( $n = 132$ ) to analyze for this variable. Due to this information, it was determined the results of the hypothesis could be erroneous.

#### **4.5 Barriers to Reporting Medication Errors**

Respondents were asked to rate eight potential barriers to reporting medication errors identified from the literature (See Table 10). Each potential barrier could be rated as a major barrier, moderate barrier, minor barrier, or not a barrier. Rank ordering identified three barriers to reporting medication errors by one-fourth or more of the



nurses as: 1) nurses are afraid of the consequences that may result if they report a medication error (100 or 29.3%); 2) if something happens to the patient due to a medication error, the nurse will be blamed (96 or 28.2%); and 3) nurses are afraid of a reprimand if they report a medication error that is made (95 or 27.9%). The nurses were least likely (10%) to support “nurses think most errors are not important enough to report” as a barrier.

**Table 10-4**  
*Perceived Barriers to Reporting Medication Errors*

	N (%)	N (%)	N (%)	N (%)
	Major Barrier	Moderate Barrier	Minor Barrier	Not A Barrier
Nurses are afraid of consequences that may result if they report a medication error.	100 (29.3)	108 (31.7)	85 (24.9)	40 (11.7)
If something happens to the patient due to a medication error, the nurse will be blamed.	96 (28.2)	122 (35.8)	70 (20.5)	42 (12.3)
Nurses are afraid of a reprimand if they report a medication error that is made.	95 (27.9)	115 (33.7)	82 (24)	43 (12.6)
If an error is prevented before it reaches the patient (near miss), it is not necessary to report.	74 (21.7)	99 (29.0)	78 (22.9)	81 (23.8)

At our facility the blame is put on the individual rather than looking at the system as a potential cause of the error	66 (19.4)	84 (24.6)	91 (26.7)	92 (27.0)
Reporting is too detailed and time consuming.	55 (16.1)	114 (33.4)	105 (30.8)	54 (15.8)
Others will think nurses are incompetent.	55 (16.1)	108 (31.7)	111 (32.6)	61 (17.9)
Nurses think most errors are not important enough to report.	34 (10.0)	115 (33.7)	105 (30.8)	73 (21.4)

*Note:*  $N$  = varies 333 to 337 due to missing data.

Independent samples t-tests were used to determine if there was a difference in nurses' perceptions of the number of barriers (total barrier score with a potential range of 8 to 32) to reporting medication errors based on having national certification (yes  $M = 20.15$ ,  $SD = 5.87$  vs. no  $M = 21.38$ ,  $SD = 5.58$ ), consistent clinical practice setting (yes  $M = 20.65$ ,  $SD = 5.79$  vs. no  $M = 20.46$ ,  $SD = 5.87$ ), and gender of the nurse (male  $M = 19.71$ ,  $SD = 5.52$  vs. female  $M = 20.68$ ,  $SD = 5.82$ ). Results of these analyses found that nurses' perceptions of the number of barriers did not differ significantly based on these variables.

In addition, an ANOVA was used to identify if nurses' perceptions of the number of barriers to reporting medication errors differed based on educational level (diploma/associates; bachelors; masters, doctoral or other), years of clinical experience (0 to 4 yrs.; 5 to 9 yrs.; 10 to 14 yrs.; 15 to 19 yrs.; 20 to 24 yrs.; 25 to 29 yrs.; 30 to 34 yrs.; 35 to 39 yrs.; 40 to 44 yrs.; 45 yrs. and above), size of hospital (<100 beds; 100 to 299

beds; 300 or > beds), and age of the nurse (20 to 29 yrs.; 30 to 39 yrs.; 40 to 49 yrs.; 50 to 59 yrs.; 60 to 69 yrs.; 70 yrs. or above). (See Table 11.) Results of these analyses also found that the total barrier scores did not differ in a statistically significant way based on the preceding variables.

**Table 11-4**

*Total Barrier Score*

Barrier		M	SD
Education Level	Diploma/Associate's	21.45	5.70
	Bachelor's	20.72	5.70
	Masters/Doctoral/Other	20.42	5.89
Years of Clinical Experience	0-4 yrs.	20.14	6.00
	5-9 yrs.	21.52	5.78
	10-14 yrs.	22.55	5.75
	15-19 yrs.	20.67	4.75
	20-24 yrs.	20.79	5.97
	25-29 yrs.	19.23	5.64
	30-34 yrs.	18.98	5.70
	35-39 yrs.	21.73	5.95
	40-44 yrs.	20.33	5.50
	≥ 45 yrs.	20.50	5.20
Size of hospital	< 100 beds	19.56	6.08
	100-299 beds	20.28	5.72
	≥ 300 beds	20.19	5.82
Age of the nurse	20-29 yrs.	21.17	6.53
	30-29 yrs.	20.57	5.85
	40-49 yrs.	20.42	5.63
	50-59 yrs.	19.88	6.00
	60-69 yrs.	20.13	4.83
	≥ 70 yrs.	24.50	2.12

#### 4.6 Factors Likely to Increase Reporting of Medication Errors

Nurses were asked to rate their perceptions of factors identified from the literature that would increase their chance of reporting medication errors (See Table 12). Ratings

included: highly likely, likely, undecided, unlikely, and highly unlikely. For reporting purposes the ratings of ‚highly likely’ and ‚likely’ were collapsed together, as were ‚unlikely’ and ‚highly unlikely’. Based on the nurses’ ratings, the top five factors which increased reporting of medication errors were: if the patient was harmed or potentially could have been harmed (91.2%); if there were benefits to reporting, such as the prevention of future errors (90.6%); if the nurse had no fear of retaliation in the work environment (88.8%); if the nurse had a positive relationship with the supervisor or clinical manager (85.6%); and, lastly, if the nurse had a positive professional relationship with physicians on the unit (83%).

**Table 12-4**  
*Factors Increasing the Chance of Reporting Medication Errors*

	N (%)	N (%)	N (%)
	Highly Likely / Likely	Undecided	Unlikely / Highly Unlikely
If the patient was harmed or potentially could have been.	311 (91.2)	15 (4.4)	8 (2.4)
If there are benefits to reporting such as the prevention of future errors, improved practice, or increased accountability.	309 (90.6)	13 (3.8)	15 (4.4)
If the nurse had no fear of retaliation in the work environment.	303 (88.8)	19 (5.6)	14 (4.1)
If the nurse had a positive relationship with the supervisor or clinical manager.	292 (85.6)	29 (8.5)	17 (5)
If the nurse had positive professional relationships with physicians on the unit.	283 (83)	30 (8.8)	24 (7.1)
If any of the 5 rights (right patient, drug, dose, time, route) of medication administration were violated.	271 (79.5)	34 (10)	33 (9.6)

If the reporting process was anonymous.	271 (79.5)	34 (10)	31 (9.1)
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*Note:* *N* = varies 334 to 338 due to missing data.

Independent samples t-tests were used to determine if there was a difference in the total score of factors likely to increase reporting of medication errors based on the variables of national certification (yes vs. no), consistent clinical practice setting (yes vs. no) and gender of the nurse (male vs. female). Results of these analyses found no statistically significant differences in the total score of factors increasing the likelihood of reporting and the above variables.

In addition, analysis of variance was used to determine if there was a difference in the total score of factors likely to increase reporting (total factors likely score with a potential range of 7 to 35) of medication errors by the following variables: educational level (diploma/associates; bachelors; masters, doctoral or other), years of clinical experience (0 to 4 yrs.; 5 to 9 yrs.; 10 to 14 yrs.; 15 to 19 yrs.; 20 to 24 yrs.; 25 to 29 yrs.; 30 to 34 yrs.; 35 to 39 yrs.; 40 to 44 yrs.; 45 yrs. and above), size of hospital (<100 beds; 100 to 299 beds; 300 or > beds), and age of the nurse (20 to 29 yrs.; 30 to 39 yrs.; 40 to 49 yrs.; 50 to 59 yrs.; 60 to 69 yrs.; 70 yrs. or above). (See Table 13.) These analyses found that there was no statistically significant difference among the total score of factors likely to increase reporting and the aforementioned variables.

**Table 13-4***Total Factors Score*

Barrier		M	SD
Education Level	Diploma/Associate's	30.92	3.77
	Bachelor's	31.09	3.88
	Masters/Doctoral/Other	30.41	4.73
Years of Clinical Experience	0-4 yrs.	30.83	3.73
	5-9 yrs.	30.63	4.36
	10-14 yrs.	31.16	3.69
	<b>15-19 yrs.</b>	<b>30.67</b>	<b>4.53</b>
	20-24 yrs.	31.07	3.86
	25-29 yrs.	30.46	4.80
	30-34 yrs.	30.21	3.92
	35-39 yrs.	32.13	2.92
	40-44 yrs.	28.56	8.35
	≥ 45 yrs.	30.78	3.70
Size of hospital	< 100 beds	30.94	5.12
	100-299 beds	29.78	5.66
	≥ 300 beds	30.79	3.62
Age of the nurse	20-29 yrs.	30.38	3.95
	30-39 yrs.	31.37	3.63
	40-49 yrs.	29.60	5.52
	50-59 yrs.	30.91	3.93
	60-69 yrs.	29.50	6.50
	≥ 70 yrs.	35.00	0.00

**4.7 Communication of Medication Errors**

The majority of nurses overwhelmingly agreed that medication errors should be communicated to the patient (70.1%). (See Table 14.) Nurses also agreed that the patients' family should be notified of an error when the patient is not capable of understanding (68.9%). In addition, over one-half (58.1%) of the nurses surveyed, felt the hospital should publish medication error report cards for the public to review.



**Table 14-4**  
*Communication of Medication Errors*

	N (%)	N (%)	N (%)
	Strongly Agree / Agree	Undecided	Disagree / Strongly Disagree
Medication errors should be reported to the patient when they occur.	239 (70.1)	79 (23.2)	20 (5.9)
Medication errors should be reported to the patient's family, when the patient is not capable of understanding what has occurred.	235 (68.9)	81 (23.8)	22 (6.5)
Medication error report cards for hospitals should be published for the public to review.	198 (58.1)	89 (26.1)	48 (14.0)

*Note:* N = varies 337 to 338 due to missing data.

#### **4.8 Perception of Medication Technology Associated with Decreasing Medication Errors**

The majority of nurses perceived that all four types of medication technologies, barcode medication administration (49.5%), computerized physician order entry (55.2%), automated medication dispensing (60.1%), and “smart infusion pumps” (63.9%) were very helpful or helpful in decreasing medication errors in their hospital (See Table 15). It was also found that 19.6% of nurses were not using “smart infusion pumps”, while 39% were not using barcode medication administration.



**Table 15-4***Perception of Medication Technology Decreasing Medication Errors*

	N (%)	N (%)	N (%)	N (%)
	Very Helpful / Helpful	Slightly Helpful	Not at all Helpful	Do Not Have Item
Smart Infusion Pumps	218 (63.9)	25 (7.3)	6 (1.8)	67 (19.6)
Automated medication dispensing	205 (60.1)	38 (11.1)	7 (2.1)	74 (21.7)
Computerized physician order entry	188 (55.2)	19 (5.6)	2 (0.6)	119 (34.9)
Barcode Medication Administration	169 (49.5)	18 (5.3)	6 (1.8)	133 (39)

*Note:* N = varies 335 to 336 due to missing data.

#### 4.9 Feelings of Safety Among Nurses

In regards to feeling safe as a patient in the hospital where they work, about three-fourths of the nurses 237 (76.2%) reported they strongly agreed or agreed that they would feel safe as a patient in the hospital where they were currently working. While 39 (11.4%) nurses were undecided, 35 (11.2%) disagreed or strongly disagreed that they would feel safe as a patient where they worked.

#### 4.10 Research Questions and Hypotheses

##### Research Question 1

Is there a relationship between nurse characteristics and medication errors?

**Hypothesis 1.1** There is no statistically significant difference in the number of self reported medication errors that caused harm to a patient between nurses with

national certification in their area of clinical practice and those without national certification.

An independent samples t-test was calculated to determine if there was a statistically significant difference between nurses who have national certification in their area of clinical practice and those without national certification in relation to the number of self reported medication errors causing harm to a patient. There was no statistically significant difference found ( $t = 1.315$ ,  $df = 323.877$ ,  $p = .19$ ). Based on this result, the hypothesis was accepted.

**Hypothesis 1.2** There is no statistically significant difference in the number of self reported medication errors that “did not harm” a patient between nurses with national certification in their area of clinical practice and those without national certification.

An independent samples t-test was calculated to determine if there was a statistically significant difference between nurses who had national certification in their area of clinical practice and those without national certification in relation to the number of self reported medication errors that “did not cause harm” to a patient. There was no statistically significant difference found ( $t = 1.09$ ,  $df = 324$ ,  $p = .28$ ). Based on this result, the hypothesis was accepted.

**Hypothesis 1.3** There is no statistically significant difference in the number of self reported medication errors by nurses that caused harm to a patient based on their number of years of clinical experience.

An ANOVA was calculated to determine if there was a statistically significant difference between nurses based on their years of clinical experience (grouped into

categories: 0 to 4 yrs., 5 to 9 yrs., 10 to 14 yrs., 15 to 19 yrs., 20 to 24 yrs., 25 to 29 yrs., 30 to 34 yrs., 35 to 39 yrs., 40 to 44 yrs.,  $\geq 45$  yrs) in the number of self reported medication errors that caused harm to a patient. There was no statistically significant difference found ( $F = .560$ ,  $df = 9$ ,  $p = .83$ ). Based on this result the hypothesis was accepted.

**Hypothesis 1.4** There is no statistically significant difference in the number of self reported medication errors by nurses that “did not cause harm” to a patient based on their number of years of clinical experience.

An ANOVA was calculated to determine if there was a statistically significant difference between nurses based on their years of clinical experience (grouped into categories: 0 to 4 yrs., 5 to 9 yrs., 10 to 14 yrs., 15 to 19 yrs., 20 to 24 yrs., 25 to 29 yrs., 30 to 34 yrs., 35 to 39 yrs., 40 to 44 yrs.,  $\geq 45$  yrs) in the number of self reported medication errors that “did not cause harm” to a patient. There was no statistically significant difference found ( $F = 1.047$ ,  $df = 9$ ,  $p = .40$ ). Based on this result the hypothesis was accepted

**Hypothesis 1.5** There is no statistically significant difference in the number of self reported medication errors that caused harm to a patient between nurses who have participated in pharmacology continuing education since than two years ago and those who have not participated in pharmacology continuing education in the past two or more years.

An independent samples t-test was calculated to determine if there was a statistically significant difference between nurses who have participated in pharmacology continuing education in the past two years and those who have not participated in the past

two years, in the number of self reported medication errors that caused harm to patients.

There was no statistically significant difference found ( $t = -.100$ ,  $df = 331$ ,  $p = .92$ ).

Based on this result the hypothesis was accepted.

**Hypothesis 1.6** There is no statistically significant difference in the number of self reported medication errors that “did not cause harm” to a patient between nurses who have participated in pharmacology continuing education less than two years ago and those who have not participated in pharmacology continuing education in the past two or more years.

An independent samples t-test was calculated to determine if there was a statistically significant difference between nurses who had participated in pharmacology continuing education in the past two years and those who had not participated in the past two years and the number of self reported medication errors that “did not cause harm” to patients. There was no statistically significant difference found ( $t = -1.376$ ,  $df = 329$ ,  $p = .17$ ). Based on this result the hypothesis was accepted.

**Hypothesis 1.7** There is no statistically significant difference in the number of self reported medication errors that caused harm to a patient among nurses with a bachelor’s degree in nursing and those with less than a bachelor’s degree (associate degree or diploma in nursing).

The respondents’ level of education was not analyzed in relation to the number of medication errors. Of respondents, 61% ( $n = 208$ ) had a masters or doctoral degree, with a large majority of these nurses identifying themselves as advanced nurse practitioners. The majority of these advanced practice nurses would not currently be working as staff nurses in the hospital setting. This issue altered the sample size of useable nurses

( $n = 132$ ) to analyze for this variable. Due to this information it was determined the results of the hypothesis could be erroneous and no further analysis was conducted.

**Hypothesis 1.8** There is no statistically significant difference in the number of self reported medication errors that “did not cause harm” to a patient among nurses with a bachelor’s degree in nursing and those with less than a bachelor’s degree (associate degree and diploma in nursing).

The respondents’ level of education was not analyzed in relation to the number of medication errors. Of respondents, 61% ( $n = 208$ ) had a masters or doctoral degree, with a large majority of these nurses identifying themselves as advanced nurse practitioners. The majority of these advanced practice nurses would not currently be working as staff nurses in the hospital setting. This issue altered the sample size of useable nurses ( $n = 132$ ) to analyze for this variable. Due to this information it was determined the results of the hypothesis could be erroneous and no further analysis was conducted.

**Hypothesis 1.9** There is no statistically significant difference in the number of self reported medication errors that caused harm to a patient between nurses who have taken a formal course in pharmacology and those whose pharmacology was integrated throughout the nursing curriculum in their undergraduate program.

An independent samples t-test was calculated to determine if there was a statistically significant difference between nurses who had taken a formal course in pharmacology and those whose pharmacology was integrated throughout the nursing curriculum in their undergraduate program and the number of self reported medication errors causing harm to a patient. There was no statistically significant difference found ( $t = -.828$ ,  $df = 282$ ,  $p = .41$ ). Based on this result the hypothesis was accepted.

**Hypothesis 1.10** There is no statistically significant difference in the number of self reported medication errors that “did not cause harm” to a patient between nurses who have taken a formal course in pharmacology and those whose pharmacology was integrated throughout the nursing curriculum in their undergraduate program.

An independent samples t-test was calculated to determine if there was a statistically significant difference between nurses who had taken a formal course in pharmacology and those whose pharmacology was integrated throughout the nursing curriculum in their undergraduate program, in the number of self reported medication errors that “did not cause harm” to a patient. There was no statistically significant difference found ( $t = -.183$ ,  $df = 280$ ,  $p = .86$ ). Based on this result the hypothesis was accepted.

**Hypothesis 1.11** There is no statistically significant difference in the number of self reported medication errors that caused harm to a patient between nurses who work full-time and those who do not work full-time.

An independent samples t- test was calculated to determine if there was a statistically significant difference between nurses who worked full-time versus those who did not work full-time and the number of self reported medication errors causing harm to a patient. There was no statistically significant difference found ( $t = .622$ ,  $df = 326$ ,  $p = .54$ ). Based on this result the hypothesis was accepted.

**Hypothesis 1.12** There is no statistically significant difference in the number of self reported medication errors that “did not cause harm” to a patient between nurses who work full-time and those who do not work full-time.

An independent samples t-test was calculated to determine if there was a statistically significant difference between nurses who worked full-time versus those who did not work full-time and the number of self reported medication errors that “did not cause harm” to a patient. There was no statistically significant difference found ( $t = .826$ ,  $df = 324$ ,  $p = .41$ ). Based on this result the hypothesis was accepted.

**Hypothesis 1.13** There is no statistically significant difference in the number of self reported medication errors that caused harm to a patient among nurses who work day shift, night shift, and rotating shifts.

An ANOVA was calculated to determine if there was a statistically significant difference among nurses who work day shift, night shift, or rotating shifts in relation to the number of self reported medication errors that caused harm to a patient. There were no statistically significant differences found ( $F = .543$ ,  $df = 2$ ,  $p = .58$ ). Based on this result the hypothesis was accepted.

**Hypothesis 1.14** There is no statistically significant difference in the number of self reported medication errors that “did not cause harm” to a patient among nurses who work day shift, night shift or rotating shifts.

An ANOVA was calculated to determine if there was a statistically significant difference among nurses who work day shift, night shift, or rotating shifts in relation to the number of self reported medication errors that “did not cause harm” to a patient. No statistically significant difference was found ( $F = 2.322$ ,  $df = 2$ ,  $p = .10$ ). Based on this result the hypothesis was accepted.

**Hypothesis 1.15** There is no statistically significant difference in the number of self reported medication errors that caused harm to a patient between nurses who

have had their mathematical skills formally tested at work within the past two years compared to those who have not had their mathematical skills formally tested at work within the past two year.

An independent samples t-test was calculated to determine if there was a statistically significant difference between nurses who had their mathematical skills formally tested in that past two years at work versus those who had not had their mathematical skills formally tested at work and the number of self reported medication errors causing harm to a patient. There was not a statistically significant difference found ( $t = -1.757$ ,  $df = 318.68$ ,  $p = .80$ ). Based on this result the hypothesis was accepted.

**Hypothesis 1.16** There is no statistically significant difference in the number of self reported medication errors that “did not cause harm” to a patient between nurses who have had their mathematical skills formally tested at work within the past two years compared to those who have not had their mathematical skills formally tested at work within the past two years.

An independent samples t-test was calculated to determine if there was a statistically significant difference between nurses who had their mathematical skills formally tested in the past two years at work versus those who had not had their mathematical skills formally tested at work and the number of self reported medication errors that “did not cause harm” to a patient. There was no statistically significant difference found ( $t = .379$ ,  $df = 331$ ,  $p = .71$ ). Based on this result the hypothesis was accepted.

**Hypothesis 1.17** There is no statistically significant difference in the number of self reported medication errors that caused harm to a patient between nurses who



consistently work in the same clinical practice setting and those that do not consistently work in the same clinical practice setting.

An independent samples t-test was calculated to determine if there was a statistically significant difference between nurses who consistently work in the same clinical practice setting versus those who do not work in the same practice setting and the number of self reported medication errors that caused harm to a patient. There was no statistically significant difference found ( $t = -1.739$ ,  $df = 162.42$ ,  $p = .08$ ). Based on this result the hypothesis was accepted.

**Hypothesis 1.18** There is no statistically significant difference in the number of self reported medication errors that “did not cause harm” to a patient between nurses who consistently work in the same clinical practice setting and those that do not consistently work in the same clinical practice setting.

An independent samples t-test was calculated to determine if there was a statistically significant difference between nurses who consistently work in the same clinical practice setting versus those who do not work in the same practice setting and the number of self reported medication errors that “did not cause harm” to a patient. There was a statistically significant difference found ( $t = -2.181$ ,  $df = 317$ ,  $p = .03$ ;  $M = 2.24$ ;  $SD = 2.98$  vs.  $M = 1.49$ ;  $SD = 2.65$ ). Based on this result the hypothesis was rejected.

**Hypothesis 1.19** There is no statistically significant difference in the number of self reported medication errors that caused harm to a patient among nurses based on the size of the hospital (e.g. number of beds) where they work.

An ANOVA was used to determine if there was a statistically significant difference among nurses based on the size of the hospital (small, medium, large) where they were working and the number of self reported medication errors that caused harm to a patient. There was no statistically significant difference found ( $F = .074$ ,  $df = 2$ ,  $p = .93$ ). Based on this result the hypothesis was accepted.

**Hypothesis 1.20** There is no statistically significant difference in the number of self reported medication errors that “did not cause harm” to a patient among nurses based on the size of the hospital (e.g. number of beds) where they work.

An ANOVA was used to determine if there was a statistically significant difference among nurses based on the size of the hospital (small, medium, large) where they were working and the number of self reported medication errors that “did not cause harm” to a patient. There was no statistically significant difference found ( $F = 1.219$ ,  $df = 2$ ,  $p = .30$ ). Based on this result the hypothesis was accepted.

**Hypothesis 1.21** There is no statistically significant difference in the number of self reported medications errors that caused harm to a patient among nurses when they have worked over 12 hours in one day as compared to those who have not worked over 12 hours in one day.

An independent samples t-test was used to determine if there was a statistically significant difference between nurses based on whether they had worked over 12 hours in one day over a two week period as compared to those who had not worked over 12 hours in one day over a two week period and the number of self reported medication errors that caused harm to a patient. There was a statistically significant difference found ( $t = -2.414$ ,  $df = 184.218$ ,  $p = .02$ ;  $M = .56$ ;  $SD = 1.13$  vs.  $M = .36$ ;  $SD = .84$ ). Nurses working over

12 hours in one day made more errors that caused harm. Based on these results the hypothesis was rejected.

**Hypothesis 1.22** There is no statistically significant difference in the number of self reported medications errors that “did not cause harm” to a patient among nurses when they have worked over 12 hours in one day as compared to those who have not worked over 12 hours in one day.

An independent sample t-test was used to determine if there was a statistically significant difference between nurses based on whether the nurse worked over 12 hours in one day over a two week period as compared to those who had not worked over 12 hours in one day over a two week period and the number of self reported medication errors that did not cause harm to a patient. There was a statistically significant difference found ( $t = -2.255$ ,  $df = 286$ ,  $p = .03$ ;  $M = 2.18$ ;  $SD = 2.53$  vs.  $M = 2.11$ ;  $SD = 3.24$ ). Nurses who had worked over 12 hours in one day made more errors that “did not cause harm”. Based on this result the hypothesis was rejected.

## **Research Question 2**

What are the factors that nurses perceive as barriers to medication error reporting?

**Hypothesis 2.1** There is no statistically significant difference in nurses’ perception of the number of barriers to reporting medication errors based on their level of education.

An ANOVA was used to determine if there was a statistically significant difference in nurses’ perceptions of the number of barriers to reporting medication errors based on level of education (associate/diploma, bachelor’s, master’s/doctoral/other).

There was no statistically significant difference found ( $F = .470, df = 2, p = .63$ ). Based on this result the hypothesis was accepted.

**Hypothesis 2.2** There is no statistically significant difference in nurses' perception of the number of barriers to reporting medication errors based on national certification.

An independent samples t-test was used to determine if there was a statistically significant difference in nurses' perceptions of the number of barriers to reporting medication errors based on whether they had national certification. There was no statistically significant difference found ( $t = -1.848, df = 304, p = .07$ ). Based on this result the hypothesis was accepted.

**Hypothesis 2.3** There is no statistically significant difference in nurses' perception of the number of barriers to reporting medication errors based on years of clinical experience.

An ANOVA was used to determine if there was a statistically significant difference in nurses' perceptions of the number of barriers to reporting medication errors by number of years of clinical experience (grouped into categories as 0 to 4 yrs., 5 to 9 yrs., 10 to 14 yrs., 15 to 19 yrs., 20 to 24 yrs., 25 to 29 yrs., 30 to 34 yrs., 35 to 39 yrs., 40 to 44 yrs.,  $\geq 45$  yrs.). There was no statistically significant difference found ( $F = 1.516, df = 9, p = .14$ ). Based on this result the hypothesis was accepted.

**Hypothesis 2.4** There is no statistically significant difference in nurses' perception of the number of barriers to reporting medication errors based on the size of hospital where the nurse works.

An ANOVA was used to determine if there was a statistically significant difference in nurses' perceptions of the number of barriers to reporting medication errors by size of the hospital where the nurse worked (small, medium, large). There was no statistically significant difference found ( $F = .231$ ,  $df = 2$ ,  $p = .79$ ). Based on this result the hypothesis was accepted.

**Hypothesis 2.5** There is no statistically significant difference in nurses' perception of the number of barriers to reporting medication errors based on whether the nurse consistently works in the same clinical setting.

An independent samples t-test was used to determine if there was a statistically significant difference in nurses' perceptions of the number of barriers to reporting medication errors based on whether the nurse consistently worked in the same clinical practice setting. There was no statistically significant difference found ( $t = -.234$ ,  $df = 297$ ,  $p = .82$ ). Based on this result the hypothesis was accepted.

**Hypothesis 2.6** There is no statistically significant difference in nurses' perception of the number of barriers to reporting medication errors based on the age of the nurse.

An ANOVA was used to determine if there was a statistically significant difference in nurses' perceptions of the number of barriers to reporting medication errors based on the age of the nurse (grouped into categories as 20 to 29 yrs., 30 to 39 yrs., 40 to 49 yrs., 50 to 59 yrs., 60 to 69 yrs.,  $\geq 70$  yrs.). There was no statistically significant difference found ( $F = .397$ ,  $df = 5$ ,  $p = .85$ ). Based on this result the hypothesis was accepted.

**Hypothesis 2.7** There is no statistically significant difference in nurses' perception of the number of barriers to reporting medication errors based on the gender of the nurse.

An independent samples t-test was used to determine if there was a statistically significant difference in nurses' perceptions of the number of barriers to reporting medication errors based on the gender of the nurse. There was no statistically significant difference found ( $t = .734$ ,  $df = 309$ ,  $p = .46$ ). Based on this result the hypothesis was accepted.

### **Research Question 3**

What are the factors that nurses perceive as increasing their likelihood of reporting medication errors?

**Hypothesis 3.1** There is no statistically significant difference in nurses' perception of the number of factors that would increase their likelihood of reporting medication errors based on level of education.

An ANOVA was used to determine if there was a statistically significant difference in nurses' perceptions of the number of factors that would increase their likelihood of reporting medication errors based on level of education (associate/diploma, bachelor's, master's/doctoral/other). There was no statistically significant difference found ( $F = .811$ ,  $df = 2$ ,  $p = .45$ ). Based on this result the hypothesis was accepted.

**Hypothesis 3.2** There is no statistically significant difference in nurses' perception of the number of factors that would increase their likelihood of reporting medication errors based on national certification.

An independent samples t-test was used to determine if there was a statistically significant difference in nurses' perceptions of the number of factors that would increase their likelihood of reporting medication errors based on national certification. There was no statistically significant difference found ( $t = -1.722$ ,  $df = 322$ ,  $p = .09$ ). Based on this result the hypothesis was accepted.

**Hypothesis 3.3** There is no statistically significant difference in nurses' perception of the number of factors that would increase their likelihood of reporting medication errors based on years of clinical experience.

An ANOVA was used to determine if there was a statistically significant difference in nurses' perceptions of the number of factors that would increase their likelihood of reporting medication errors based on years of clinical experience (grouped into categories as 0 to 4 yrs., 5 to 9 yrs., 10 to 14 yrs., 15 to 19 yrs., 20 to 24 yrs., 25 to 29 yrs., 30 to 34 yrs., 35 to 39 yrs., 40 to 44 yrs.,  $\geq 45$  yrs.). There was no statistically significant difference found ( $F = .883$ ,  $df = 9$ ,  $p = .54$ ). Based on this result the hypothesis was accepted.

**Hypothesis 3.4** There is no statistically significant difference in nurses' perception of the number of factors that would increase their likelihood of reporting medication errors based on the size of hospital where the nurse works.

An ANOVA was used to determine if there was a statistically significant difference in nurses' perceptions of the number of factors that would increase their likelihood of reporting medication errors based on the size of the hospital where the nurse works (small, medium, large). There was no statistically significant difference found ( $F = 1.488$ ,  $df = 2$ ,  $p = .23$ ). Based on this result the hypothesis was accepted.

**Hypothesis 3.5** There is no statistically significant difference in nurses' perception of the number of factors that would increase their likelihood of reporting medication errors based on whether the nurse consistently works in the same practice setting.

An independent samples t-test was used to determine if there was a statistically significant difference in nurses' perceptions of the number of factors that would increase their likelihood of reporting medication errors based on whether the nurse consistently worked in the same clinical practice setting. There was no statistically significant difference found ( $t = -1.075$ ,  $df = 315$ ,  $p = .28$ ). Based on this result the hypothesis was accepted.

**Hypothesis 3.6** There is no statistically significant difference in nurses' perception of the number of factors that would increase their likelihood of reporting medication errors based on the age of the nurse.

An ANOVA was used to determine if there was a statistically significant difference in nurses' perceptions of the number of factors that would increase their likelihood of reporting medication errors based on the age of the nurse (grouped into categories as 20 to 29 yrs., 30 to 39 yrs., 40 to 49 yrs., 50 to 59 yrs., 60 to 69 yrs.,  $\geq 70$  yrs.). There was no statistically significant difference found ( $F = 1.436$ ,  $df = 5$ ,  $p = .21$ ). Based on this result the hypothesis was accepted.

**Hypothesis 3.7** There is no statistically significant difference in nurses' perception of factors that would increase their likelihood of reporting medication errors based on the gender of the nurse.



An independent samples t-test was used to determine if there was a statistically significant difference in nurses' perceptions of factors that would increase their likelihood of reporting medication errors based on the gender of the nurse. There was no statistically significant difference found ( $t = -.277$ ,  $df = 328$ ,  $p = .78$ ). Based on this result the hypothesis was accepted.

#### **Research Question 4**

Do nurses support open communication regarding medication errors?

**Hypothesis 4.1** The majority of nurses will support communicating to the patient when a medication error has occurred.

The majority (70.1%) of nurses supported communicating to the patient when a medication error had occurred. Due to this result this hypothesis was accepted.

**Hypothesis 4.2** The majority of nurses will support communicating to the family (in appropriate circumstances) when a medication error has occurred.

The majority (68.9%) of nurses supported communicating to the family (in appropriate circumstances) when a medication error has occurred. Due to this result this hypothesis was accepted.

**Hypothesis 4.3** The majority of nurses will support medical error report cards for hospitals that are reported to governmental agencies, and then published for the public to review.

The majority (58.1%) of nurses supported medical error report cards for hospitals that reported errors to governmental agencies, and then published for the public to review. Due to this result this hypothesis was accepted.

## **Research Question 5**

Do nurses perceive the use of medication technology as helpful in reducing medication errors in the acute care setting?

**Hypothesis 5.1** The majority of nurses will perceive barcode medication administration as helpful or very helpful in reducing medication errors within their hospital.

The majority (49.5%) of nurses perceived barcode medication administration as helpful or very helpful in reducing medication errors within their hospital. Due to this result this hypothesis was accepted

**Hypothesis 5.2** The majority of nurses will perceive computerized physician order entry as helpful or very helpful in reducing medication errors within their hospital.

The majority (55.2%) of nurses perceived computerized physician order entry as helpful or very helpful in reducing medication errors within their hospital. Due to this result this hypothesis was accepted.

**Hypothesis 5.3** The majority of nurses will perceive automated medication dispensing as helpful or very helpful in reducing medication errors within their hospital.

The majority (60.1%) of nurses perceived “smart infusion pumps” as helpful or very helpful in reducing medication errors within their hospital. Due to this result this hypothesis was accepted.

**Hypothesis 5.4** The majority of nurses will perceive automated medication dispensing as helpful or very helpful in reducing medication errors within their hospital.

The majority (63.9%) of nurses perceived “smart infusion pumps” as helpful or very helpful in reducing medication errors within their hospital. Due to this result this hypothesis was accepted.

#### **4.11 Summary**

The purpose of the current study was to survey registered nurses in the United States to determine their perceptions related to medication errors including: primary causes of medication errors, nurses experience with medication errors causing harm and no harm, barriers to reporting medication errors, factors likely to increase reporting of medication errors, communication of medication errors, and technology associated with decreasing medication errors. This chapter presented the results of the surveys completed by the nurses. A total of 41 hypotheses were tested, 38 were accepted, while three were rejected. Two hypotheses were not tested because characteristics of the sample and size of the sample might cause skewed data resulting in invalid findings.

Results of the research indicated that the majority of nurses who responded to the survey were female, white, and mature. In addition, the majority of nurses held an advanced degree (master’s or doctorate) and have attained national certification, with two thirds of the nurses having greater than ten years of clinical experience with a mean of 20.0 yrs. The majority of the nurses who responded worked full-time and worked in or were associated with a hospital setting. Approximately one-third of the nurses worked over 12 hours in one day at least one to two times per two week pay period, and up to as

much as five or more times in that same time period. The majority of nurses did work in the same clinical practice setting when they were at work.

In regards to undergraduate and continuing education, a majority of nurses participated in formal pharmacology courses while pursuing their undergraduate degrees.

The majority of nurses reported having attended some type of continuing education in pharmacology within the past year. Approximately one-half of all responding nurses, reported they had never had their mathematical skills tested since becoming a nurse, or it had been greater than five years since having these skills tested.

Three hypotheses relating to background characteristics of nurses were found to have statistically significant differences in the number of self reported medication errors. First, there was a statistically significant difference found between nurses who consistently worked in the same clinical practice setting and those that did not consistently work in the same setting and the number of medication errors that “did not harm” a patient. Second, a statistically significant difference was found in the number of medication errors that caused harm to a patient among nurses when they had worked over twelve hours in one day as compared to those who had not worked over 12 hours in one day. Third, there was also a statistically significant difference in the number of self reported medication errors that „did not cause harm” to a patient among nurses when they had worked over twelve hours in one day as compared to those who had not worked over 12 hours in one day.

Rank ordering of the primary causes of medication errors identified the following top five causes: interruptions during medication pass, short RN staffing, nurses caring for high acuity patients, nurses working more than 12 hours in one shift, and nurse

knowledge of medications being administered. Three-fourths of nurses reported that they had not made a medication error in the past 12 months that resulted in harm to a patient. While one in eight reported they had made at least one error that had resulted in some type of harm to the patient. One in nine nurses reported they had made two or more errors that had resulted in harm to a patient over a 12 month period. The highest number of medication errors made by a nurse and causing harm to patients, was six.

In regard to medication errors that “did not harm” the patient, a little more than one in three nurses reported not having made a medication error in the past 12 months. One in five nurses reported having made one medication error and reported making two or three errors over a 12 month period. Approximately one in five of nurses reported making four or more errors that “did not cause harm” to a patient over a 12 month period.

Rank ordering identified the following three barriers to reporting medication errors by about one-fourth of the nurses: nurses are afraid of the consequences that may result if they report a medication error, if something happens to the patient due to a medication error, the nurse will be blamed and nurses are afraid of a reprimand if they report a medication error that has been made. Whereas, the nurses rated the top five factors which increased their reporting of medication errors: 1) if the patient was harmed or potentially could have been; 2) if there were benefits to reporting such as the prevention of future errors, improved practice, or increased accountability; 3) if the nurse had no fear of retaliation in the work environment; 4) if the nurse had a positive relationship with the supervisor/clinical manager; and, 5) if the nurse had positive professional relationships with physicians on the unit.

The majority of nurses agreed overwhelmingly that medication errors should be communicated to the patient. Two-thirds of nurses also agreed that the patients' family should be notified of an error when the patient is not capable of understanding. In addition, over one-half of the nurses surveyed, believed the hospital should publish medication error report cards for the public to review. Also, the majority of nurses perceived that all four types of medical technologies, barcode medication administration; computerized physician order entry; automated medication dispensing and "smart infusion pumps" were helpful or very helpful in decreasing medication errors in their hospital. Lastly, about three-fourths of the nurses reported they strongly agreed or agreed that they would feel safe as a patient in the hospital where they currently worked.

## **Chapter 5**

### **Conclusions**

This chapter contains the following sections: Summary, Accepted Hypotheses, Rejected Hypotheses, Discussion, Implications, and Recommendations for Future Research.

#### **5.1 Summary**

This study was conducted to answer the following questions:

1. Is there a relationship between nurse characteristics and medication errors?
2. What are the factors that nurses perceive as barriers to medication error reporting?
3. What are the factors that nurses perceive as increasing their likelihood of reporting medication errors?
4. Do nurses support open communication regarding medication errors?
5. Do nurses perceive the use of medication technology as helpful in reducing medication errors in the acute care setting?

A four page questionnaire was developed to investigate nurses' perceptions of medication errors based on the Injury Prevention Model/Matrix by W. Haddon. The

survey instrument was designed following a comprehensive review of the literature and an expert panel review. Survey items included: contributing factors to medication errors, experiences with medication errors, barriers to reporting medication errors, factors increasing likelihood of reporting medication errors, communication of medication errors, helpfulness of medication administration technology, and nurse demographics and characteristics. Subjects for this study were registered nurses from across the United States who were members of the American Nurses Association. The study included registered nurses who graduated with a diploma, associate, bachelor's, master's or doctoral degrees and were actively working. From a membership of nearly 168,000 nurses a random national sample of 5,000 names was purchased through American List Counsel. Following an *a priori* power analysis, 800 nurses were randomly selected from the 5,000 names to participate by taking every sixth name from across the file. After excluding the non-deliverable and non-useable surveys, 341 completed surveys were used for the study, producing a final response rate of 49%. Descriptive statistics, independent t-tests and ANOVA were used for the statistical analyses.

Results of the study identified that there was a statistically significant difference in the number of self reported medication errors for those that caused harm and those that “did not cause harm” among nurses who worked over 12 hours in one day. Those nurses who worked more than 12 hours in one day had an increased number of errors. Also, a statistically significant result was found for those who did not consistently work in the same clinical practice setting. Nurses who did not consistently work in the same setting had fewer errors that “did not cause harm” compared to those that had consistently worked in the same setting. In addition, there were no statistically significant differences



found in the number of barriers to reporting or the number of factors likely to increase reporting of errors. Nurses did agree overwhelmingly that medication errors should be communicated to the patient or the family if the patient was not capable of understanding. Nurses also believed hospitals should publish medication error report cards for the public to review. Lastly, three-fourths of all nurses surveyed would feel safe as a patient in the hospital where they worked.

## **5.2 Accepted Hypotheses**

Out of the original 43 hypotheses, 38 were accepted, and two were not run due to the high educational level of the sample (61% had a masters or doctoral degree), this left the sample size of useable surveys to 38.7%. The following hypotheses were accepted:

### **Research Question 1**

Is there a relationship between nurse characteristics and medication errors?

#### **Hypothesis 1.1**

There is no statistically significant difference in the number of self reported medication errors that caused harm to a patient between nurses with national certification in their area of clinical practice and those without national certification.

#### **Hypothesis 1.2**

There is no statistically significant difference in the number of self reported medication errors that did not harm a patient between nurses with national certification in their area of clinical practice and those without national certification.

### **Hypothesis 1.3**

There is no statistically significant difference in the number of self reported medication errors by nurses that caused harm to a patient based on their number of years of clinical experience.

### **Hypothesis 1.4**

There is no statistically significant difference in the number of self reported medication errors by nurses that did not cause harm to a patient based on their number of years of clinical experience.

### **Hypothesis 1.5**

There is no statistically significant difference in the number of self reported medication errors that caused harm to a patient between nurses who have participated in pharmacology continuing education since less than two years ago and those who have not participated in pharmacology continuing education in the past two or more years.

### **Hypothesis 1.6**

There is no statistically significant difference in the number of self reported medication errors that did not cause harm to a patient between nurses who have participated in pharmacology continuing education less than two years ago and those who have not participated in pharmacology continuing education in the past two or more years.

### **Hypothesis 1.9**

There is no statistically significant difference in the number of self reported medication errors that caused harm to a patient between nurses who have taken a formal

course in pharmacology and those whose pharmacology was integrated throughout the nursing curriculum in their undergraduate program.

#### **Hypothesis 1.10**

There is no statistically significant difference in the number of self reported medication errors that did not cause harm to a patient between nurses who have taken a formal course in pharmacology and those whose pharmacology was integrated throughout the nursing curriculum in their undergraduate program.

#### **Hypothesis 1.11**

There is no statistically significant difference in the number of self reported medication errors that caused harm to a patient between nurses who work full- time and those who do not work full-time.

#### **Hypothesis 1.12**

There is no statistically significant difference in the number of self reported medication errors that did not cause harm to a patient between nurses who work full- time and those who do not work full-time.

#### **Hypothesis 1.13**

There is no statistically significant difference in the number of self reported medication errors that caused harm to a patient among nurses who work day shift, night shift or rotating shifts.

#### **Hypothesis 1.14**

There is no statistically significant difference in the number of self reported medication errors that did not cause harm to a patient among nurses who work day shift, night shift or rotating shifts.

### **Hypothesis 1.15**

There is no statistically significant difference in the number of self reported medication errors that caused harm to a patient between nurses who have had their mathematical skills formally tested at work within the past two years compared to those who have not had their mathematical skills formally tested at work within the past two year.

### **Hypothesis 1.16**

There is no statistically significant difference in the number of self reported medication errors that did not cause harm to a patient between nurses who have had their mathematical skills formally tested at work within the past two years compared to those who have not had their mathematical skills formally tested at work within the past two years.

### **Hypothesis 1.17**

There is no statistically significant difference in the number of self reported medication errors that caused harm to a patient between nurses who consistently work in the same clinical practice setting and those that do not consistently work in the same clinical practice setting.

### **Hypothesis 1.19**

There is no statistically significant difference in the number of self reported medication errors that caused harm to a patient among nurses based on the size of the hospital (small <100 beds, medium 100-299 beds, large 300 or more beds) where they work.

### **Hypothesis 1.20**

There is no statistically significant difference in the number of self reported medication errors that did not cause harm to a patient among nurses based on the size of the hospital (small <100 beds, medium 100-299 beds, large 300 or more beds) where they work.

### **Research Question 2**

What are the factors that nurses perceive as barriers to medication error reporting?

### **Hypothesis 2.1**

There is no statistically significant difference in nurses' perception of barriers to reporting medication errors based on level of education.

### **Hypothesis 2.2**

There is no statistically significant difference in nurses' perception of barriers to reporting medication errors based on national certification.

### **Hypothesis 2.3**

There is no statistically significant difference in nurses' perception of barriers to reporting medication errors based on years of clinical experience.

### **Hypothesis 2.4**

There is no statistically significant difference in nurses' perception of barriers to reporting medication errors based on the size of hospital where the nurse works.

### **Hypothesis 2.5**

There is no statistically significant difference in nurses' perception of barriers to reporting medication errors based on whether the nurse consistently works in the same clinical setting.

### **Hypothesis 2.6**

There is no statistically significant difference in nurses' perception of barriers to reporting medication errors based on the age of the nurse.

### **Hypothesis 2.7**

There is no statistically significant difference in nurses' perception of barriers to reporting medication errors based on the gender of the nurse.

### **Research Question 3**

What are the factors that nurses perceive as increasing their likelihood of reporting medication errors?

### **Hypothesis 3.1**

There is no statistically significant difference in nurses' perception of factors that would increase their likelihood of reporting medication errors based on level of education.

### **Hypothesis 3.2**

There is no statistically significant difference in nurses' perception of factors that would increase their likelihood of reporting medication errors based on national certification.

### **Hypothesis 3.3**

There is no statistically significant difference in nurses' perception of factors that would increase their likelihood of reporting medication errors based on years of clinical experience.

### **Hypothesis 3.4**

There is no statistically significant difference in nurses' perception of factors that would increase their likelihood of reporting medication errors based on the size of hospital where the nurse works.

### **Hypothesis 3.5**

There is no statistically significant difference in nurses' perception of factors that would increase their likelihood of reporting medication errors based on whether the nurse consistently works in the same practice setting.

### **Hypothesis 3.6**

There is no statistically significant difference in nurses' perception of factors that would increase their likelihood of reporting medication errors based on the age of the nurse.

### **Hypothesis 3.7**

There is no statistically significant difference in nurses' perception of factors that would increase their likelihood of reporting medication errors based on the gender of the nurse.

### **Research Question 4**

Do nurses support open communication regarding medication errors?

### **Hypothesis 4.1**

The majority of nurses will support communicating to the patient when a medication error has occurred.

#### **Hypothesis 4.2**

The majority of nurses will support communicating to the family (in appropriate circumstances) when a medication error has occurred.

#### **Hypothesis 4.3**

The majority of nurses will support medical error report cards for hospitals that are reported to governmental agencies, and then published for the public to review.

#### **Research Question 5**

Do nurses perceive the use of medication technology as helpful in reducing medication errors in the acute care setting?

#### **Hypothesis 5.1**

The majority of nurses will perceive barcode medication administration as helpful or very helpful in reducing medication errors within their hospital.

#### **Hypothesis 5.2**

The majority of nurses will perceive computerized physician order entry as helpful or very helpful in reducing medication errors within their hospital.

#### **Hypothesis 5.3**

The majority of nurses will perceive automated medication dispensing as helpful or very helpful in reducing medication errors within their hospital.

#### **Hypothesis 5.4**

The majority of nurses will perceive “smart infusion pumps” as helpful or very helpful in reducing medication errors within their hospital.



### **5.3 Rejected Hypotheses**

#### **Research Question 1**

Is there a relationship between nurse characteristics and medication errors?

##### **Hypothesis 1.18**

There is no statistically significant difference in the number of self reported medication errors that did not harm a patient between nurses who consistently work in the same clinical practice setting and those that do not consistently work in the same clinical practice setting.

##### **Hypothesis 1.21**

There is no statistically significant difference in the number of self reported medications errors that caused harm to a patient among nurses when they have worked over twelve hours in one day as compared to those who have not worked over 12 hours in one day.

##### **Hypothesis 1.22**

There is no statistically significant difference in the number of self reported medications errors that did not cause harm to a patient among nurses when they have worked over twelve hours in one day as compared to those who have not worked over 12 hours in one day.

### **5.4 Discussion**

This section will discuss nurses' perceptions of medication errors in terms of: primary causes of medication errors, nurses' experiences with medication errors, barriers to reporting medication errors, factors likely to increase reporting of medication errors,

communication of medication errors, and perceptions of medication technology in decreasing medication errors.

#### **5.4.1 Primary Causes of Medication Errors**

The results of this study identified the following factors as the primary causes of medication errors: interruptions during medication administration, short RN staffing, nurses caring for high acuity patients, nurses working more than 12 hours in one shift, and the nurses knowledge level of the medications being administered. A study by Balas, Scott and Rogers (2004) identified that 33% of medication errors were due to late administration with nurses expressing that high patient acuity and heavy workloads altered their ability to pass medications in an efficient fashion. In addition, nurses frequently described interruptions and distractions when preparing medications. A study by Mayo and Duncan (2004) also identified that distractions by other patients, coworkers, or events on a unit, along with nurses working when tired and exhausted were ranked in the top three primary causes of medication errors. Furthermore, in a study by Osborne, Blais and Hayes (1999) nurses identified that working while tired and exhausted was a leading factor contributing to medication errors, while Wakefield et al. (1998) identified interruptions during medication administration a primary contributing factor to errors. The current study provides results from the first large national random sample with appropriate methods. In the past, similar surveys have had problems with small sample size, low return rates, instrument reliability and a lack of an organizing theory/framework (See Table 2). In addition, the current study has been carried out since the 2000 IOM report was issued, which resulted in many changes taking place in the health care arena regarding safety issues.

#### 5.4.2 Nurses Experience with Medication Errors

All health care personnel involved in medication administration are aware of the potential for error, both serious and non-serious. While the majority of nurses in this study (75%) had not made a medication error causing harm in the past 12 months, one fourth of the nurses responding to the survey had made a severe error causing harm. Sixty percent of nurses reported making one or more errors that “did not cause harm” in the past twelve months. Additionally, this study found statistically significant results for errors causing harm, and those causing no harm when a nurse worked over 12 hours in one day. A study by Rogers, Hwang, Scott, Aiken and Dinges (2004) found that nurses who worked more than 12 consecutive hours had significantly higher error rates. While a 1986 study by Jones and Brown specifically looked at the number of medication errors in relation to 12 hour shifts as compared to eight hour shifts found no significant relationship, the type of medication error (serious versus non-serious) was not taken into account. Currently, JCAHO does identify certain medication errors as *sentinel events*, these are errors that lead to death or serious physical or psychological injury as opposed to errors that “do not cause harm” and require little or no intervention (JCAHO, 2006).

A study by Chang and Mark (2009) investigated differences in antecedents of severe and non-severe medication errors. These researchers found the greater the level of nursing expertise on the unit (team factor), the fewer non-severe errors ( $p < 0.01$ ), though this did not hold true with severe errors. They also found that as the percentage of BSN prepared nurses on the unit increased (team factor), severe medication errors decreased until the percentage of BSN nurses reached 54%. In the current study that

looked at expertise as an individual factor, there was no significant relationship between number of errors and years of experience for either errors causing harm, or “no harm.”

In the current study, there was a statistically significant difference in the number of self reported medication errors that “did not cause harm” between nurses who consistently worked in the same clinical practice setting versus those who did not, with the mean number of errors being lower for those who did not consistently work in the same practice setting. Though this result was unexpected, it might be explained by the fact that nurses working in an unfamiliar setting may be more careful while administering medications they do not usually administer, or it is possible that their workload ( number of patients) or acuity level (difficulty of patients) may have been lower since they were not assigned to their normal work place. Additionally, nurses working consistently in the same practice setting may be paying less attention to what they are doing, due to the familiarity with their work, along with the possibility of having a heavier workload either in number of patients or a higher acuity level with their patient group.

#### **5.4.3 Factors Associated With Medication Error Reporting**

Due to the number of medication errors that occur and the potential for serious outcome, it is crucial that nurses report errors in a timely and efficient manner. When a medication administration error occurs and is reported, it can then be analyzed to determine the source and the cause of the error, not only from a risk management perspective but also for continuous quality improvement (Wakefield et al., 1999). The top three barriers to reporting errors identified in the current study were: nurses are afraid of the consequences that may result if they report a medication error, if something happens to the patient due to an error the nurse will be blamed, and nurses were afraid of

a reprimand if they reported a medication error. In the study by Wakefield et al. (1999), the researchers identified four major subscales in relation to barriers to reporting medication errors, which included: disagreement over whether it was an error, reporting effort, fear, and administrative response. The barriers identified in the current study were included under the subscales, fear and administrative response. In addition, Stratton, et al. (2004), found that pediatric nurses identified nursing administrators' focus on the person, rather than the system, and fear of adverse consequences were the primary reasons for not reporting medication errors. Furthermore, a major theme revealed in the research by Walker and Lowe (1998) regarding reporting was "self preservation." This theme related to "getting into trouble" or "standing out from the crowd" as seen by those in authority, also demonstrating a fear of reprimand that influenced medication error reporting.

In the current study, nurses identified the following top five factors as increasing their chance of reporting medication errors: if the patient was harmed or potentially could have been, if there were benefits to reporting, such as the prevention of future errors, if the nurse had no fear of retaliation in the work environment, if the nurse had a positive relationship with the supervisor/clinical manager and lastly, if the nurse had a positive professional relationship with physicians on the unit. These results concur with the aforementioned barriers to reporting in this study, as well as the 2001 study by Wakefield et al. who found a positive association between the likeliness to report medication administration errors in a group-oriented culture (supportive, trust, people oriented) versus a hierarchical (controlling) or rational (production and efficiency) culture type. In addition, Walker and Lowe's (1998) study identified that incidents that were life

threatening to patients had a positive influence on the nurses' reporting of medication errors.

#### **5.4.4 Communication of Medication Errors**

Disclosure of errors is foundational to patient safety, an ethical obligation, and an accreditation standard (Garbutt et al., 2007). Since 2001, the Joint Commission on Accreditation of Healthcare Organizations has required disclosure of adverse outcomes (JCAHO, 2005). In the current study nurses agreed overwhelmingly that medication errors should be communicated to the patient or to the family if the patient is not capable of understanding what has occurred. Furthermore, the majority of nurses felt that hospitals should publish medication error report cards for the public to review. A review of the literature by Mazer, Simon, and Gurwitz (2004) on the disclosure of medical errors to patients and families found that research has been limited on the issue, though both patients and the public support disclosure. The literature indicated that physicians support disclosure, but frequently do not disclose. In addition, a 2009 study by Shannon, Foglia, Hardy, and Gallagher found that nurses routinely communicate nursing errors (errors within control or accountability of a nurse) that did not involve serious harm, but have not been involved when patient harm had occurred or when errors involved the entire health care team. Most nurses in the study were not aware of their hospitals' policies on disclosure, but would like a role in the process so they could communicate directly with the patient or family about nursing's role in the event to alleviate concern regarding blame for a team error (Shannon et al., 2009).

#### **5.4.5 Technology Utilized to Decrease Errors**

The majority of nurses perceived that all four types of medical technologies: barcode medication administration, computerized physician order entry, automated medication dispensing and “smart infusion pumps” helped to decrease medication errors in their hospital. In the current study, the review of the literature on safety systems demonstrated the use of medication administration technology does have the ability to increase safety for both the patient and the nurse. No particular safety system or practice has been identified as best to prevent medication errors. The review suggests a combination of systems, along with vigilance and communication between healthcare providers (physicians, nurses, pharmacists), may have the largest impact in reducing medication errors.

#### **5.4.6 Feelings of Safety Among Nurses**

In this study, three-fourths of the nurses agreed or strongly agreed they would feel safe as a patient in the hospital where they worked, while one-fourth of nurses were undecided or disagreed about feelings of safety. Since the 2000 publication of *To Err Is Human* by the IOM, concern regarding errors in hospitals has skyrocketed, though little is known about the status of hospitalized patients’ safety perceptions (Wolosin, Vercler, & Matthews, 2006). In telephone interviews surveying over 1,600 patients from 12 Midwestern hospitals, researchers found that 94% of patients believed that their medical safety had been good to excellent during their hospitalization, though 39% of these patients had at least one concern regarding safety during their stay (Burroughs et al., 2007). Most concerns were over medications errors or another mistake made by the nurse. Frequency of patient concerns was associated with decreased willingness to

recommend the hospital (Burroughs et al., 2007). In a national survey by Wolosin, et al. (2006), the researchers found an average rating of 87.8 for perceptions of patient safety during their hospitalization. In addition, providing information about rights and related topics at registration increased feelings of safety compared to those given less information. Also, patients without roommates felt significantly safer than those who shared a room, while increasing length of stay decreased perceived safety (Wolosin et al., 2006).

## **5.5 Implications**

The way healthcare providers think about injury/error will determine how effective we will be in reducing the burden of error in America (Christoffel & Gallagher, 2006). Over the past several decades, the focus on injury has shifted from both a biological and behavioral perspective on the individual to an emphasis on the environmental context in which the injury occurs (host, agent, and environment) (Christoffel & Gallagher, 2006). There has also been a conceptual shift from a single-cause explanation of injury to a more multi-faceted (systems) approach. In addition, prevention of injury/error involves open communication and collaboration of many disciplines such as physicians, nurses, pharmacists, patients, and those in administrative positions within the acute care setting. Utilizing the Haddon Model/Matrix in the current health care environment with the problem of medication errors helps direct specific interventions to the major sources of error such as human factors, agent, physical and the socio-cultural environment. Additionally, using the Haddon Model/Matrix with medication errors allows the error to be further analyzed by identifying the phase in which the error occurred, such as pre-event, event, or post-event phase. Analyzing



medication errors in this manner allows for more focused and appropriate prevention strategies. In relation to the Haddon Matrix, findings from the current study suggest that nurses perceive human factors, as well as the physical environment in the pre-event phase, as major contributing causes of medication errors. In addition, the socio-cultural environment is important to the likelihood of reporting medication errors post-event.

Despite the increased attention to medication errors since *To Err is Human* was published in 2000, the 2006 IOM report *Preventing Medication Errors*, states “that about one medication error occurs per patient per day in hospital care” (p. 99). This suggests that medication errors remain a sizeable problem. The major purpose of the current study was to re-examine nursing characteristics contributing to medication errors in acute care hospitals across the nation, along with the reporting of those errors. Results of the current study have implications for patient well-being and how to minimize medication error morbidity and mortality.

Findings from the current study suggest that allowing nurses to work over 12 hours in one day (pre-event), whether voluntary or involuntary, could have potentially serious consequences for patients. In addition, nurses perceive short RN staffing and caring for higher acuity patients (event) increases the likelihood of errors. No associations were found for medication errors that cause harm or those that “did not cause harm” in regards to certification, years of experience, pharmacology education, work status, shift worked, math skills or size of hospital.

This research shows nurses are more likely to report errors if reporting the error will benefit the patient in any way, if there is no fear of retaliation in the work place having reported an error (post-event), as well as having positive working relationships

with both managers and physicians the nurse works with on the unit. In addition, the majority of nurses support open communication of errors to patients and family members, along with the publication of medication error report cards for the public to review. Further, nurses are the professional group most likely to report an error to a patient or family member, though they are not routinely involved in disclosure of “team” errors to patients and or families, but would like to be included due to concern regarding blame for errors.

The majority of nurses perceive that medication technology such as bar code medication administration, computerized physician order entry, automated dispensing, and “smart infusion pumps” decrease medication errors and increase safety for hospitalized patients. The IOM (2006) currently recommends technological interventions for the prevention of medication errors in hospital care, specifically CPOE with decision support systems.

This study highlights the significant role nurses play in the medication administration process, along with its complexity and involvement of numerous health care professionals. Results of this study have serious implications for individual staff nurses, nurse administrators, as well as hospital administration and hospital systems in terms of medication error reduction and patient safety.

## **5.6 Recommendations for Future Research**

Based on the finding of the current study, the following recommendations are offered for further research:

1. To identify if factors contributing to harmful medications are different from those that “do not cause harm.”

2. About the process of how medication errors are disclosed to patients and what do patients prefer.
3. To identify “work around” strategies associated with the different types of medication administration technology that may result in new errors.
4. To identify appropriate staffing levels and mix of staff, acuity levels of patients, and shift length or amount of time worked without a break in terms of impact errors and patient safety.
5. To discern if a difference exists between reportable and non-reportable medication errors.
6. Identify types of interruption which may cause medication errors and strategies to decrease errors to be used during medication preparation and administration.
7. Evaluate the impact of medication administration technology on preventable harm in hospitalized patients.
8. To identify how “culture of safety” principles are being incorporated into nursing curricula.

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## Appendices

### Appendix A: Survey Instrument

#### Nurses' Perceptions of Medication Errors

**Directions:** Please complete each of the following items according to the instructions. Your responses will be confidential. Do not put your name on this survey.

**Definition of Medication Error:** *For the purpose of this survey, medication error is defined as any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is in the control of the healthcare profession.*

1. How often are each of the following a primary cause of medication errors? (please rate)	Never	Rarely	Sometimes	Most Of The Time	Always
A. Nurse must calculate the dose of the drug.					
B. Nurse knowledge of medication being administered.					
C. Interruption during medication pass.					
D. Unclear policy and procedures regarding medication administration.					
E. Short RN staff.					
F. Nurse caring for high acuity patients.					
G. Nurse works more than 12 hours in one shift.					
H. Nurse works more than 40 hours in one week.					
I. Incomplete medication order.					
J. Nurse not familiar with unit environment.					
K. Nurse has limited clinical knowledge.					
L. Hostile work environment.					
M. Other (please specify and rate)					

2. Please identify your experiences with medication errors (please circle number).

A. How many medication errors did **you or a colleague** make during the past 12 months that resulted in harm to a patient?

0   1   2   3   4   5   6   7   8   9   10   Over 10

B. How many medication errors did **you or a colleague** make during the past 12 months that did **not** harm the patient?

0   1   2   3   4   5   6   7   8   9   10   Over 10

C. How many medication errors were reported over the past 12 months? (please fill in)

1. Medication errors that caused harm \_\_\_\_\_.

2. Medication errors that did not cause harm \_\_\_\_\_.

3. Please rate how much of a <u>barrier</u> each of the following are:		Major Barrier	Moderate Barrier	Minor Barrier	Not A Barrier
A.	At our facility the blame is put on the individual rather than looking at the system as a potential cause of the error.				
B.	Others will think nurses are incompetent.				
C.	Nurses think most errors are not important enough to report.				
D.	If something happens to the patient due to a medication error, the nurse will be blamed.				
E.	Reporting is too detailed and time consuming.				
F.	Nurses are afraid of a reprimand if they report a medication error that is made.				
G.	Nurses are afraid of the consequences that may result if they report a medication error.				
H.	If an error is prevented before it reaches the patient (near miss), it is not necessary to report.				
I.	Please specify: other barriers to reporting medication errors (please rate). _____				

4. How likely would the following factors <u>increase</u> your chance <u>of reporting</u> a medication error that you or someone else made? (please rate)		Highly Likely	Likely	Undecided	Unlikely	Highly Unlikely
A.	If any of the 5 rights (right patient, drug, dose, time, route) of medication administration were violated.					
B.	If the reporting process was anonymous.					
C.	If the patient was harmed or potentially could have been.					
D.	If there are benefits to reporting such as the prevention of future errors, improved practice, or increased accountability.					
E.	If the nurse had no fear of retaliation in the work environment.					
F.	If the nurse had a positive relationship with the supervisor/clinical manager.					
G.	If the nurse had positive professional relationships with physicians on the unit.					
H.	Please specify other factors that would increase your probability of reporting a medication error (please rate). _____					

5. Please rate your agreement or disagreement with the following statements.	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
A. Medication errors should be reported to the patient when they occur.					
B. Medication errors should be reported to the patient's family, when the patient is not capable of understanding what has occurred.					
C. Medication error report cards for hospitals should be published for the public to review.					

6. How helpful has the following technology been in <u>decreasing</u> medication errors in the facility in which you work? (please rate)	Very Helpful	Helpful	Slightly helpful	Not Helpful at All	Not Sure	Do Not Have This
A. Barcode medication administration						
B. Computerized physician order entry						
C. Automated medication dispensing						
D. "Smart infusion pumps"						

**NURSE DEMOGRAPHICS AND CHARACTERISTICS: (please check mark)**

- Gender:      ☐ Female      ☐ Male
- Race/Ethnicity (please indicate the background you most identify with):  
☐ African American      ☐ Hispanic      ☐ White  
☐ Asian/Pacific Islander      ☐ Native American/Alaskan Native  
☐ Other (please specify) \_\_\_\_\_
- Age \_\_\_\_\_ (years)
- Check highest level of education:  
☐ Diploma in Nursing ( 2 or 3 years )  
☐ Associate Degree in Nursing      ☐ Master Degree in Nursing  
☐ Bachelor Degree in Nursing      ☐ Other (please specify) \_\_\_\_\_
- Do you currently have **national certification** in a clinical specialty?      ☐ Yes      ☐ No  
**Certification Specialty:** \_\_\_\_\_
- Number of years of clinical experience since graduation?      \_\_\_\_\_ years
- How many years has it been since you attended any **pharmacology continuing education**?  
☐ < 1 year    ☐ 1    ☐ 2    ☐ 3    ☐ 4    ☐ 5    ☐ 6    ☐ 7    ☐ 8    ☐ 9    ☐ 10 or more



8. How was **pharmacology** taught in your undergraduate nursing program?  
☐ Formal pharmacology course    ☐ Pharmacology integrated throughout curriculum  
☐ Other (please specify) \_\_\_\_\_
9. What is your work schedule?    ☐ Full-time    ☐ Part-time    ☐ Per diem
10. Which **shift** do you work?  
☐ 12 hour shift day    ☐ 12 hour shift night    ☐ rotate 12 hour shift  
☐ 8 hour shift day    ☐ 8 hour shift evening    ☐ 8 hour shift night  
☐ Rotate 8 hours day/eve    ☐ Rotate 8 hours day/night    ☐ Rotate 8 hours eve/night  
☐ Other \_\_\_\_\_
11. As a registered nurse how long has it been since your **mathematical skills** have been formally tested (e.g. in-house continuing education, skills review)?  
☐ < 1 year    ☐ 1-2 years    ☐ 3-4 years    ☐ 5 years or more    ☐ Never
12. How frequently do you work more than 12 hours in one day?  
☐ Never    ☐ 1-2 times in 2 week period    ☐ 3-4 times in 2 week period  
☐ 5 or more times in 2 week period    ☐ Other (please specify) \_\_\_\_\_
14. I would feel safe being a patient in the hospital that I am currently working. (Please circle one)  
Strongly Agree    Agree    Undecided    Disagree    Strongly Disagree
15. When you are working in clinical practice, do you normally (Check only one):  
☐ Work in the same clinical practice setting  
☐ Work as part of the float pool  
☐ Work various hospitals and different floors (from an outside agency)  
☐ Work on a long-term assignment, several months or more (from an outside agency)  
☐ Other (please specify) \_\_\_\_\_
16. The size of the hospital I am currently working in would be classified as:  
☐ Fewer than 100 beds (small)    ☐ 100-299 beds (medium)    ☐ 300 plus beds (large)  
☐ Do not work in hospital
17. My primary place of employment is outside the hospital setting:  
☐ Extended Care facility    ☐ Office type setting  
☐ Community Health setting    ☐ Hospice  
☐ Other: \_\_\_\_\_    ☐ I do work in a hospital
18. If working in a hospital the type of unit/area most often worked is: (choose only one response)  
☐ Medical    ☐ Surgical    ☐ Medical/Surgical    ☐ Step-down  
☐ Obstetrics    ☐ Pediatrics    ☐ Pediatric ICU    ☐ Neonatal ICU  
☐ Adult ICU    ☐ Psychiatric    ☐ Long term care unit within the hospital  
☐ Other (please specify): \_\_\_\_\_

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*Thank You for participating in this National Nursing Study!*

## Appendix B: Human Subjects Approval Letter



The University of Toledo  
Department for Human Research Protections  
Social, Behavioral & Educational Institutional Review Board  
Office of Research, Rm. 2300, University Hall  
2801 West Bancroft Street, Mail Stop 944  
Toledo, Ohio 43606-3390  
Phone: 419-530-2844 Fax: 419-530-2841  
(FWA00010685)

To: James H. Price, Ph.D. and Mary Jo Maurer  
Department of Public Health and Homeland Security

From: Barbara K. Chesney, Ph.D., Chair  
Wesley A. Bullock Ph.D., Vice Chair

Signed: \_\_\_\_\_ Date: 02/02/09

Subject: IRB #106297

Protocol Title: *Nurses' Perceptions of Medication Errors in the Acute Care Setting*

On 02/02/09, the Protocol listed below was reviewed and approved by the Chair and the Chair Designee of the University of Toledo (UT) **Social Behavioral & Educational** Institutional Review Board (IRB) via the expedited process. You have also been granted a waiver from the requirements of a written consent form. This action will be reported to the committee at its next scheduled meeting.

Items Reviewed:

- IRB Application Requesting Expedited Review
- Survey (Version Date 02/02/09)

This protocol approval is in effect until the expiration date listed below, unless the IRB notifies you otherwise.

Approval Date: 02/02/09	Expiration Date: 02/01/10
-------------------------	---------------------------

Number of Subjects Approved: 800

Please read the following attachment detailing Principal Investigator responsibilities.

## Appendix C: Letter 1

March 1, 2009

«NAME»  
«ADDRESS»  
«CITY», «STATE» «ZIP»-«ZIP4»

Dear

We invite you to participate in this **national research study** entitled “Nurses’ Perceptions of Medication Errors”. You are one of a group of registered nurses that have been randomly selected to participate in this study examining nurses’ perceptions of medication errors, medication error reporting and medication administration technology. Due to your important role in the medication administration process this puts you in an excellent position to identify the causes of medication errors and help prevent future errors from occurring.

Enclosed are a survey, a postage paid return envelope, and a \$1.00 bill. We realize that the \$1 enclosed does not reimburse you for your time, but we hope that you can use it to purchase a bottle of water, cup of coffee, or a soft drink “on us”. The survey will take less than **10 minutes** to complete. Please do not write your name or any other personally identifying information on the survey. All of your answers will remain **confidential** and only group results will be analyzed.

This research has been approved by the University of Toledo Human Subjects Committee. If you have any questions at any time before, during or after your participation you should contact the Project Director, Dr. James Price at (419) 383 6786 or by email, JPrice@UTNet.UToledo.Edu.

Thank you for your professional courtesy in completing this survey. Your response within the next **week** would be greatly appreciated!

Thank you, again, for your time and consideration.

Sincerely,

Mary Jo Maurer MSN, RN, CNS  
Doctoral Student  
Division of Health Education

James H. Price, Ph.D., MPH  
Professor of Public Health  
University of Toledo

## Appendix D: Letter 2

March 23, 2009

«NAME»  
«ADDRESS»  
«CITY», «STATE» «ZIP»-«ZIP4»

Dear «NAME»,

About two weeks ago, the Department of Public Health, Division of Health Education at the University of Toledo mailed you a survey on nurses' perceptions of medication errors. Your participation is very important to ensure the success of the study.

If you have returned the survey, **thank you very much.** If you have not returned the survey, a second copy and a self-addressed stamped envelope has been included for your convenience. We appreciate your busy schedule and thank you for your participation. The survey takes less than 10 minutes to complete. All of your answers will remain **confidential** and only group results will be analyzed.

Thank you again for your professional courtesy in completing this survey. Your response within the next **week** would be greatly appreciated!

Sincerely,

Mary Jo Maurer MSN, RN, CNS  
Doctoral Student  
Division of Health Education

James H. Price, Ph.D., MPH  
Professor of Public Health  
University of Toledo

## Appendix E: Letter 3

April 6, 2009

Name

Address

City, State, Zip

Dear First Last,

Recently, the Department of Public Health at The University of Toledo mailed you a survey on nurses' perceptions of medication errors. Your participation is very important to ensure the success of the study. If you do not wish to participate in this study it will not affect your relationship with the University of Toledo.

If you have returned the survey, **thank you very much.** If you have not returned the survey a third copy and a self-addressed envelope has been included for your convenience. We appreciate your busy schedule and thank you for your participation. The survey takes about 9 minutes to complete and all responses are **confidential**. If you have any questions at any time regarding the survey please contact the Project Director, Dr. James Price at 419 383 6787 or by email, [JPrice@UTNet.UToledo.Edu](mailto:JPrice@UTNet.UToledo.Edu).

Thank you again for your professional courtesy in completing this survey. Your response within the **next week** would be greatly appreciated!

Sincerely,

Mary Jo Maurer MSN, RN, CNS

Doctoral Student

Division of Health Education

James H. Price, Ph.D., MPH

Professor of Public Health

## Appendix F: Post Card

Dear Colleague: **WE NEED YOUR HELP!!**

Recently, the Department of Public Health at The University of Toledo mailed you a survey on nurses' perceptions of medication errors. If the survey has been completed and returned, please accept our thanks and disregard this reminder. If you have not yet had an opportunity to respond, please consider taking about 9 minutes to complete and return the survey. If you do not wish to participate in this study it will not affect your relationship with the University of Toledo. Your responses are **confidential**. Please call 419 383 6786 if you need an additional copy of the survey.

Mary Jo Maurer MSN, RN, CNS  
Doctoral Student

James H. Price, Ph.D., MPH  
Professor of Public Health

## **Appendix G: Panel of Experts**

### Panel of Experts

Dr. Sherry Everett Jones, PhD, MPH, JD, FASHA  
Division of Adolescent and School Health  
National Center for Chronic Disease Prevention and Health Promotion  
Centers for Disease Control and Prevention  
4770 Buford Hwy, NE  
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Dr. Bonnie J. Wakefield, PhD, RN  
Research Scientist  
VA Medical Center  
601 Hwy 6 W  
Iowa, City, IA 52246

Ms. Virginia M Ulanimo, MS, RN, CCRN  
VAPAHCS  
Palo Alto, CA 94304

## **Appendix H: Letter to Experts**

Mary Jo Maurer  
8139 Timothy Lane  
Sylvania, Ohio 43560-1080

November 17, 2008

Dear:

I am a doctoral student working with Dr. James H. Price on the following dissertation topic “Nurses’ Perceptions of Medication Errors in the Acute Care Setting”. Dr. Price suggested you as a possible content/survey method external reviewer for my questionnaire.

Please find attached a copy of my questionnaire which will be used in a national survey of hospital nurses. The questionnaire has the following sections: factors causing medication errors, experiences with medication errors, barriers to reporting medications errors, factors increasing likelihood of reporting, communication of medication errors, technology associated with medication administration and nurse demographics and characteristics.

Please do the following in your review:

- Delete any items not needed
- Please add any additional items that you believe are important
- Please reword any items that are not clear

Thank you for your assistance. We would like to request your response in the next two weeks. If you have any questions or concerns please feel free to contact me at [mjmaurer@bex.net](mailto:mjmaurer@bex.net) or (H) xxx-xxx-xxxx.

Respectfully,

Mary Jo Maurer MSN, RN, CNS  
Doctoral student  
University of Toledo