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Effectiveness of Guardrails at Reducing Medication Errors inDrug Administration

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This is to certify that the doctoral study by

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Walden University
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Abstract

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MS, Walden University, 2016

BS, Georgia College & State University, 2014

ProjectSubmitted in Partial Fulfillment

of the Requirements for the Degree of

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Abstract

Medication errors during drug administration are an issue in the nursing profession. The errors that occur due to intravenous vein infusions pose threats to patients due to the mode of administration and the risk of occurrence. Strategies such as guardrails have been implemented to reduce the rate of such errors. Despite these guardrails, facilities record mixed results on the effectiveness of infusion pumps in reducing medication errors. The project was designed as a quantitative study to evaluate the effectiveness of guardrails in reducing medication errors at the facility. Data analysis included error reports from the facility before and after the implementation of the guardrails, as well as reports from the software used to monitor the effectiveness of the infusion pumps. Descriptive statistics was used to determine the frequency distribution, percentages, and mean, while *t*-tests were conducted on the two paired samples. Results showed errors reduced to 7% after the intervention, with a steady decline over the years. The *p*-value of 0.001 showed that there was a significant difference ($\alpha \leq 0.05$) after the use of guardrails and prior to their usage, indicating that the intervention was effective in reducing the occurrence of medication errors. These findings can be used to promote positive social change at the facility to reduce the occurrence of medication errors during drug administration. The data will be useful to hospital administrators, nursing managers, and nursing staff to encourage compliance in the use of guardrails to help reduce medication errors.

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Section 1: Nature of the Project

Introduction

Safety during hospitalization is one of the rights accorded to patients, and it is a priority for healthcare professionals. However, reports of incidents occurring in patient settings (i.e., patient falls, pressure ulcers, the use of the wrong equipment, medication errors during drug administration,and acquired hospital infectionshave raised concern regarding the safety and quality of patient care. Errors during the medication process are a common occurrence worldwide. They are defined as "preventable adverse effects of care, whether or not it is evident or harmful to patient, but this might include an inaccurate or incomplete diagnosis or treatment of a disease, injury, syndrome, behavior, infection, or other ailment. Such events may be related to professional practice, health care products, procedures, and systems, including prescribing; order communication; product labeling, packaging, nomenclature; compounding; dispensing; distribution; administration; education; monitoring; and use" (Reddy, Modi, Chaudhary, Modi, & Patel,2009, p. 184-185).

Medication errors are health careestimated to result in $177 billion of drug-related morbidity and mortality annually in the United States (Reddy et al., 2009). More than 7,000 preventable deaths occur every year due to preventable medical errors, which accounts for 0.1% of the errors (Efstratios, 2012). Furthermore, medication errors occur in one of every fivedoses administered in hospitals, although the number could be higher due to underreporting, which results in one death daily and 1.3 million injuries due to the adverse effects of medication administration errors (Shahrokhi, Ebrahimpour,

&Ghodousi, 2013). However, these cases are judged to be preventable, thus the concern about the frequency and effects of medication errors on patients.

The common errors that occur during the medication administration process result from the issue such as administering the wrong dosage (40.9%), overdose (36.4%), administering the wrong drug (19%), and using the wrong route for drug administration (9.5%; Cloete, 2015). These errors occur due to various reasons like poor communication, knowledge deficits, overworking and fatigue of the staff, understaffing and disruptions, and distractions during the administration process (Hayes, Jackson, Davidson, & Power, 2015).

Many approaches have been proposed and implemented to target and address the problem, although the issue persists and raises concern among nursing professionals. The issue of medication errors came to the limelight following the Institute of Medicine (IOM, 1999) report showing the severity of medication errors during drug administration. More than 44,000 deaths annually occur due to medication errors in hospitals alone, with more than 7,000 deaths due to the errors (Shahrokhi et al., 2013).

The U. S. health system has put in place measures and strategies to re-evaluate and strengthen checks and balances to prevent the occurrence of medication errors during drug administration. The Food and Drug Administration FDA (2004) enhanced its efforts and resources towards addressing medication errors during drug administration. An example of an approach in place is the formation of a new division tasked with monitoring medication errors before and after a drug reaches the market (Chahal, 2017). In addition, the FDA is addressing medication errors by working to reduce the confusion

between drug names that look or sound similar. The FDA reviews more than 300 names every year before marketing through simulation and the use a computerized program to detect and compare names (Chahal, 2017). After the approval of drugs, the FDA also tracks such medicines through the system and collects error reports on such drugs that are spread among health care professionals to spread awareness on the risks of errors occurring with such drugs.

Drugs are also labelled according to FDA (2004) standards that require that the label indicates the name along with the active ingredients, dosage, usage, directions, and contraindications. Another key area in which the FDA is working to reduce such errors is in the use of bar codes on medication. The FDA proposed and implemented a new rule requiring that health care professionals use bar code scanning equipment to ensure that the right drug in the right dosage is administered through the correct route, and at the right time, to the correct patient (USDA, 2017). When patients enter a medical facility, they receive a bar-coded wristband used to transmit information to the hospitals computer. Through this wristband, the nurses scan the wristband that conveys information on the medicine prescribed (Young, Slebodnik, & Sands, 2013). The barcode provides unique identifying information concerning the drug prescribed to a patient, which is used before any medicine is administered. Despite these precautions, medication errors remain as one of the most common medical errors (Shahrokhi et al., 2013).

The administration stage is the most vulnerable stage to medication errors and Intravenous Infusion IV infusion errors that involve high risk medications delivered directly into the patient's blood stream and have the greatest potential for patient harm

(Trbovich, Pinkney, Cafazzo, & Easy, 2010). Medications administered intravenously account for 56% of medication errors and 54% of potential errors (Pang,Kong, Clifford, Lam, & Leung, 2011). A large number of high-risk medications, such as insulin and morphine, are delivered intravenouslydue to the risks involved with the infusion devices. Apart from the risky medicines administered through infusion pumps, the devices have a high risk of medication errors becausethey are not easily integrated into the standalone systems of most medical facilities used to monitor medication administration (Gerhart, O'Shea, & Muller, 2013). Infusion pumps are usually programmed to deliver medicine depending on the weight of the patient and at a predetermined rate. For example, a pump can deliver medicine to a patient weighing 50kg at a rate of 5ml/hr (author, year). Such devices are risky because unless a programming error is intercepted before pressing the start button, the misprogrammed dose will be delivered to the patient.

Without safeguards in place, it is easy to inadvertently deliver a massive over or underdose by missing a decimal point or by putting in a wrong code. There is also a risk of errors due to the variability in drug names, dose units and limits, infusion rates, and weight and volume limits (Reddy, Modi, Chaudhary, Modi, & Patel, 2009). Errors related to IV infusion have a higher chance of causing harm to the patient, especially if the error is not intercepted before the pump is programmed (Trbovich et al., 2010). In light of these risks, numerous strategies have been employed to address errors associated with the use of IV pumps.

One such measure is the use of guardrails, which is a safety software designed for use with infusion pumps. The software works from the point of care by allowing the

creation of customized areas and profiles (Pang et al. 2011). Each profile contains a drug and IV fluid library as well as drug-specific clinical advisories that can customize how infusions are delivered by setting safety limits within a given patient care area (Trbovich et al., 2010). Through the use of guardrails, a facility can implement safety parameters along various infusion modalities (Trbovich, P. L., Pinkney, S., Cafazzo, J. A., &Easty, 2010). The guardrails software generates reports and graphics that can be used to measure the effectiveness of the safety practices.

Despite the potential benefits of the use of guardrails, many hospitals still struggle to attain high rates of compliance with their use, with some nurses circumventing or overriding the alerts and technology. There are many factors that may lead to noncompliance with the technology, such as poorly developed libraries and databases that do not reflect the situation on the ground or even a lack of standardization of the libraries (Ohashi, K., Dalleur, O., Dykes, P. C., & Bates, 2014).Another reason for workarounds may be due to a lack of proper education and sensitization of the staff on the need and proper use of the guardrails, poor accountability, and alert fatigue. DeLaurentis, Hsu, Armenta, and Bitan (2016) reported that while hospitals had implemented the technology, 31% of infusion relied on outdated databases, which resulted in nurses working around the technology to administer medication. It was essential to evaluate the effectiveness of such technologies and alleviate any workarounds on the use of guardrails in administering medication.

Problem Statement

Preparing and administering medication is an aspect of patient care, although it has the potential to result in adverse outcomes due to medication errors. Nurses are responsible for preparing and administering medicine, and errors can occur at any point in the process, due to various personal, environmental, and systemic and institutional factors. More than 450,000 medication errors occur annually resulting in more than 7,000 preventable deaths and billions of losses due to the morbidity and mortality caused (Efstratios, 2012; Hayes et al., 2015). The deaths and losses occur despite the implementation of measures such as drug labelling, the use of guard rails,and bar-code scanning that have been put in place to prevent the occurrence of errors during medicine administration.Guardrails have been employed to address the incidence of errors due to medicine infusion, which work by having hospital-defined drug libraries that include dosing limits, clinical advisories, and programming parameters. There was a need to explore the benefits of such measures, as compared to the use of traditional pumps in delivering IV medication, and the impact of guardrails on medication errors during the drug administration process.

Purpose Statement

Medication errors during drug administration are an issue of concern to the profession due to resultant harm to patients and the professionals. Although various reasons have been proposed as causes for such errors, the strategies used to address the issue have not been successful, becausemedication errors are still prevalentin the profession. The purpose of this quality improvement project was to assess the impact of

guardrails in alleviating medication errors during the administration process, in comparison with the traditional methods of IV infusion.

It was expected that the project will answer the following research question: Was the implementation and use of guard rails during the administration of IV medication among nurses in a hospital setting effective in reducing the occurrence of medication errors? It was also expected that it wouldprovide a useful guide when developing interventions towards addressing the issue of medication errors during drug administration.

Nature of the Doctoral Project

The project was conducted at a general medical and surgical hospital, which was appropriate due to the availability and access to reports on the implementation of guardrails in the facility. It was designed as a quality improvement project using preexisting data in the form of error reports as well as reports on the implementation and use of guardrails at the facility.

The data weremade up of error reports from the facility before and after the implementation of the guardrails, as well as reports on the use of the guardrails. The error reports were useful in determining the impact of the guardrails in reducing medication errors, by comparing the use of the technology with the occurrence/ recorded errors at the facility. The data collected were only used for the purposes of this project, after which any records collected for the project were destroyed by either formatting the hard drives or burning any paper records generated during the research**.** In addition, only the research

team had access to the records to maintain the privacy and confidentiality of the information.

Significance

Medication errors during drug administration may result in severe consequences for the patients. Medication safety is a core component of the nursing process, and there is a need for insights into the process that result in errors during drug administration, because the issue is significant to the nursing staff and patients, as well the facilities in which they work. The study was useful in evaluating the effectiveness of guardrails in reducing errors related to the use of IV infusion pumps at the facility, also in determining the rate of the uptake and implementation of the technology. Through this project, it was possible to determine the impact of the guardrails on error reduction and on the medication administration process.The project was also relevant to the health facility because it helped to resolve a practice issue and improve care and patient outcomes at the facility.

Summary

Medication errors during drug administration are an issue of concern for the nursing profession due to their frequency of occurrence and the adverse effects on patients. However, this is not a new issue to the profession, and there have been numerous strategies as well as interventions aimed at addressing the issue in practice. These strategies are aimed at reducing the risk of medication errors occurring during the administration phase, such as the use of barcode scanners or drug labeling. The use of

guardrails is an intervention aimed at reducing the risk of errors occurring due to the use of infusion pumps.

The risk of errors occurring due to IV medication is more severe due to the potency of the medication and the use of programming to administer the medication. Guardrails are an intervention aimed at reducing programming errors while giving IV medication. Despite the intervention, facilities still record workaround among nurses in the use of the technology, and there was a need to evaluate the effectiveness of the intervention in reducing medication errors during drug administration. It was also important to assess the uptake of the intervention, which will be useful in designing strategies to increase the use and effectiveness of the technology.

Section 2: Background and Context

Introduction

Preparing and administering medication is an aspect of patient care, although it has the potential to result in adverse outcomes due to medication errors. Nurses are responsible for preparing and administering medicine, and errors can occur at any point in the process, due to various personal, environmental, and institutional factors. More than 450,000 medication errors occur annually in the United Kingdom, the United States, and Canada, resulting in fatalities and other unprecedented medical events (Hayes et al., 2015).

The occurrence of medication errors during drug administration has been attributed to be due to various factors, such as understaffing, working long shifts, fatigue among nurses, and the presence of distractions and interruptions in the environment**(**Hayes et al., 2015. The practice setting has instituted numerous approaches to address the issue of medication errors, such as the use of barcode during medication administration. The issue of medication errors during drug administration is still an issue at the practice setting, thus necessitating the need for a project to evaluate the various techniques used in addressing the issue.

In this project, I focused on the use of guardrails in IV medication, and I evaluated the uptake and effectiveness of the intervention. IV medication has been selected due to the severity of the consequences due to IV medication errors, as well due to the continued reports of infusion errors, despite the intervention (Ohashi, Dalleur, Dykes, & Bates, 2014). Scholars have reported barriers and undercompliance in the use

of smart pumps, due to factors such as the use of outdated databases and libraries, poor education among staff on the use of the technology, or alert fatigue (DeLaurentis et al., 2016).

There wasa need to evaluate the effectiveness of the guardrails at the institution and to determine the rate of uptake and compliance among the staff. It was expected that the project would answer following the research question: Was the implementation and use of guard rails during the administration of IV medication among nurses in a hospital setting effective in reducing the occurrence of medication errors? It was also expected that it wouldprovide a guide when developing interventions towards the problem. The project was designed to lead interventions and recommendations that will maximize the use of the guardrails.

Section 2 includes the concepts and theories used to guide the project, as well as the context and background to the project on the factors contributing to the occurrence of errors at the facility. The section ends by outlining my role in the project.

Concepts, Models, and Theories

Nursing models, concepts, and theories are essential to nursing because they can be used to address practice issues, such as the occurrence of medication errors during drug administration. In this quality improvement project, Ievaluated the use of guardrails in reducing medication errors at the practice facility. Through such nursing concepts and theories, it is possible to explain and understand such practice issues and to develop strategies for resolving them. Nursing theoriesare a group of related concepts that can be used to explain occurrences, propose action, and guide practice.

Neuman's System Theory

Neuman's systems theory was first published in 1972 (Ahmadi & Sadeghi, 2017). In thetheory, Neuman focused on systems and provided a comprehensive and holistic approach to nursing by focusing on the response of the system to actual and potential stressors. The theory was designed to focus on the individual patient as an individual system (Ahmadi& Sadeghi, 2017). However, as with all nursing theories, it can be adapted to focus on the system in which the patient is receiving care. The systems theory is based on several assumptions, first off is that every system is unique with specific characteristics (Khatiban, Oshvandi, Borzou, & Moayed, 2016). Every system or environment in which nurseswork to administer medicine is composed of unique factors and characteristics of the structure.

There are numerous known and unknown universal stressors within these systems that may have an impact on the nurse during the medication process (Efstratios, 2012)**.** Each stressor has the potential to disturb the stability of the system depending on the defences set up. Due to these stressors, there have been mechanisms and responses that have been put in place that help to respond to and cope with the environmental stressors.

Every system is vulnerable to stressors, although there is a response/ defence mechanism to such stressors. The nursing environment, when administering medication, is vulnerable to stressors that may result in errors during the process due to disturbances in the system/ environment. According to Hayes et al. (2015), the medicine administration phase is vulnerable to errors due to the simultaneous demands, interruptions, and disturbances that occur during the process.

Administering medicine does not occur in isolation from other work, and how the disturbances and stressors are managed impactsthe ability to deliver safe and patient-centered care. Some of these interruptions may come from fellow staff; the patients; or even medical devices such as computers or other auditory and visual distractions like alarms, overhead pages, and alerts (Institute for Safe Medication Practices; ISMP, 2012). Stressors affect the ability to perform the task at hand and may lead to some steps being repeated or omitted, or the entire task may be repeated orabandoned (Hayes et al., 2015).However, every system has a range of responses in place that are useful in identifying the deviation from the normal. At times, the defence mechanism is not adequate in protecting the system against a stressor, and it leads to the stressor breaking through and interfering with the stability of the system.

Based on Neuman's (1972) theory, it is possible to identify and protect the system from stressors at the primary, secondary, and tertiary levels. Each of these levels involves assessing and identifying the risk for stressors in the system, the reaction of the system to stressors, and addressing these issues to reduce their effect of the system (Khatiban et al., 2016). The theory was appropriate to the project because it provided a systems approach, where the nursing unit and process is considered in the context of the environment in which it exists. Nurses do not administer medication in a vacuum, but that they work in an environment that is susceptible to different stressors.

Through the systems approach, it was possible to identify the stressors that are out of the norm in the environment, their effect on the drug administration process, and the appropriate response or defences required. Neuman's (1972) placed an emphasis on

identifying environmental stressors and responding to them that will be useful in guiding the project.

Nightingale's Theory of Environment

Nightingale played a role in shaping the nursing profession. Nightingale is responsible for advancing the environmental theory, in which the restoration of the patients' health is a function of the nurse's delivery of health care. The theory of environment focuses on the environment, which consists of the external conditions and influences and how they contribute to health, disease, and death in a patient (Medeiros, Enders, & Lira, 2015). Nightingale focused on environmental conditions such as ventilation, water, cleanliness, and lightand how they contribute to the recovery of patients. Nightingale advanced the concept that poor environmental conditions have adverse on patient health while a good environment will reduce disease (as cited inMedeiros et al., (2015). The environmental theory addresses the issue of the environment and how it can be manipulated to promote the health of the patient.

Nursing theories are useful in guiding the profession because they provide the foundation by which nurses' practice. Nightingale (1860) laid the foundation of nursing by relating the environment in which nurses' practice with their performance and patient outcomes. The modern health care environment has been effective in addressing environmental components such as ventilation, light, and air that are useful in promoting the health of the patient. However, as described by Shahrokhi et al. (2013), the presence of medication errors in the nursing environment indicates that there may be some factors that affect nursing performance, leading to medication errors during drug administration.

Nightingale suggested that the nursing environment is an indicator of nursing performance and patient outcomes (as cited in Medeiros et al., 2015). In order to address the issue of medication errors during drug administration, it is vital to understand the environment in which nurses work, how it affects their work (such as programming the guardrails),and the outcome on the patient. The outcome, in this case, referred to the occurrence of medication errors during drug administration. In addition, the environmental theory can be used together with Neuman's (1972) systems theory to look at the nursing environment as a whole and to identify and address any stressors that may affect the work of the nurse.

Technology Acceptance Model

Research and innovation in science and technology have led to innovations that impact health care delivery and improve patient outcomes. However, the benefits of such technologies can only be realized if nurses accept and fully use the innovations. The technology acceptance model (TAM) was developed and applied in health care settings to understand and increase adoption of technology and improve the quality of care offered (Strudwick, 2015). The model was developed by adapting the theory of reasoned action (TRA) as a means of understanding the behavioral intentions of staff required to use new technology in the workplace. The TAM theory is useful in predicting a person's intention based on his or her attitudes and subjective norms towards a certain behaviour, which often leads to the actual behaviour (Strudwick, 2015). The TAM is used to determine the user's attitude as well as his or her perception of the usefulness and ease of use of the technology, which will determine whether or not he or she will adopt the technology.

When considering the use of guardrails as a strategy to reduce medication errors, it was also necessary to examine the uptake and adoption of the intervention by nurses through the use of the TAM. Although the technology may be available at the facility, professionals need to adopt it and put it to use accurately for the intervention to be beneficial. Despite the potential benefits offered by guardrails in reducing medication errors during IV infusions, many hospitals still struggle to attain high rates of compliance with their use, with some nurses circumventing or overriding the alerts and technology (DeLaurentis et al., 2016). The TAM was used to explain the reluctance of nurses to adopt the technology and the reasons for workarounds, which was useful in increasing acceptance and the use of the technology during drug administration.

Lewin's Change Theory

Lewin (1947) created the change theory as a way of modelling change in human systems. The theory is based on the assumption that human behavior is dynamic based on forces pulling in opposite directions (Batras, Duff, & Smith , 2016). According to the change theory, there are driving forces that push in different directions that cause a change to occur (Batras et al. 2016). However, there are restraining forces that tend to push human systems in opposite directions until equilibrium is established that will maintain change (Batras, Duff,& Smith, 2016). The theory was relevant to the project, due to the need for change in hospital systems to reduce the occurrence of medication errors during drug administration. It was important to assess the effect of change in the organization through the use of guardrails and whether there was a need for additional strategies to ensure the effectiveness of the technology in reducing medication errors.

Lewin (1947) proposed three steps by which to effect change in an organization. The first step is the unfreezing process where there is a change of behavior to change the status quo. This is necessary to overcome resistance to the proposed changes by either decreasing the restraining forces or increasing forces that drive behavior away from a particular direction (Batras et al., 2016). The second step involves implementing the identified change in the organization followed by the refreezing stage, which is expected to sustain the change in the organizational culture and values. The theory was useful in guiding the driving and restraining forces that may be offer resistance to any changes aimed at reducing the occurrence of medication errors during drug administration.

Application of the change management theory.

The first step of the theory involves identifying the area that requires a change, in this case implementing guard rails to reduce mediation errors due to IV medication at the facility. The step was accomplished through various steps such as communicating with the relevant stakeholders like the hospital administration and nurse managers and planning and decision-making processes where the staff was engaged to understand the importance of the project and benefits to patient care.

The second step of Lewin's change theory was followed by the unfreezing stage to identify and remove potential barriers to the project. The second step included resistance from the staff to the use of computerized devices, lack of computer experience, or aversion to the new system. The barriers were removed through the use of driving forces, such as support from the upper management and the release of resources to invest in the training and education of the staff. The third step is the moving stage where the

project was implemented at the facility. The implementation stage required support from various players and departments in the facility.

The final stage was the refreezing stage where the change has been implemented and there is a need for stability and evaluation of the change. This quality improvement project is relevant at this stage where it is necessary to evaluate the effectiveness of the project, whether it succeeded in meeting the required objectives, and the need for future changes or modifications.

Terms Used

*Guardrails:*These are automated infusion pump systems designed to reduce errors by programming information to correspond with drug orders.

Medication errors: Preventable events that may cause or lead to the inappropriate medication use or patient harm, while the medicine is in the control of the health care professional, patient, or consumer(Reddy et al., 2009).

Relevance to Nursing Practice

Drug administration is a core component of the nurse in a clinical setting with a nurse administering as many as 50 medications in every shift (Hayes et al., 2015). Of these, one of every five doses administered in hospitals could result in errors (Shahrokhi et al., 2013). Although the process by which medicine is administered to patients involves a long process starting from when the drug is prescribed to when it is administered, errors during the administration process represent the largest cause of errors in a hospital setting, resulting in more than 7,000 deaths annually and more than 1.3 million injuries

(Shahrokhi et al., 2013). Nurses, therefore, have a duty and responsibility in the search of a strategy to reduce medication errors during drug administration. The medication errors in drug administration are said to occur due to multiple reasons such as overworking and fatigue among the staff, errors during prescribing, and distractions and interruptions in the environment. There have been many interventions, like having a reporting system in place or having educational programs to educate nurses on how to handle distractions and interruptions in the workplace.

These intervention have had mixed results in reducing medication errors during drug administration. For example, the use of infusion pumps has had mixed outcomes with some scholars showing that such pumps reduce errors when compared with traditional pumps, while others indicate that the pumps do not reduce the frequency of errors and may even introduce new errors (Trbovich et al., 2010). It is important to assess the impact of the intervention at the facility on the occurrence of medication errors during drug administration.

The project was relevant to the profession because it was useful in assessing the impact of guardrails on medication errors when administering IV medication and in determining the uptake of the technology among the staff. Additionally, it resulted in solutions that can be applicable in the hospital context and help minimize medication errors. Furthermore, the findings from the project are useful in guiding and improving nursing practice.

Background and Context

Medication errors may be considered from a multidisciplinary perspective because they can happen at any stage of the medication preparation and distribution process. However, more than one-third of the errors occur during the nurse administration phase, indicating that medication administration is a high-risk activity (Cloete, 2015). According to the National Coordination Council for Medication Error Reporting and Prevention (2014), a medication error is any preventable event related to medication that may result in a failure of the treatment process and may lead to or has the potential to lead to harm to the patient. These errors often contribute to adverse events, compromise the safety of the patient, and place a burden on the health system. The patients and their families may be subjected to financial burdens as well as other effects on their health. I stopped reviewing here due to time constraints. Please go through the rest of your section and look for the patterns I pointed out to you. I will now look at Section 3.

Medication administration is complex and involves multiple interactions, while being a high-risk activity (Cloete, 2015). There are different types of errors that can be witnessed during the process, which are often caused by patient, system and personal factors (Cloete, 2015). Patient factors refer to patient characteristics that increase their chances of experiencing a medication error. These may include poor communication among the patients, for example among babies and unconscious patients; multiple medications prescribed for the patients, for example, those with complex disease process or with multiple conditions and passive involvement among the patients (Cloete, 2015).

Personal factors refer to the characteristics of the professional, that contribute to the increased risk of occurrence of medication errors, while systemic factors relate to the characteristics of the organization, including the safety culture, communication in the workplace and the policies, protocols, and procedures in place to handle such issues. By considering systematic factors, it is an acknowledgment that individual members of staff have a role in and responsibility for errors that occur, although many could be prevented by placing greater emphasis on the system instead of apportioning blame on individuals (Hayes et al. 2015).

Organizational Safety Culture

Organizations should aim to understand the factors, processes, and systems that lead to medication errors, and identify strategies that will be helpful in minimizing errors. Many factors contribute to a culture of safety within the organization, including having effective communication within multidisciplinary teams. Nurses are uniquely placed to prevent errors at an administrative level by prompting prescriptions, identifying and informing the pharmacy about wrongly dispensed medication and prompting and advising on prescriptions.

Apart from having active interdisciplinary communication, a culture of safety should encourage communication and education of patients about their medications, which may be useful in informing and getting patients to be more involved in the medication process. This will have the effect of improving the quality and safety of medication administration.

Distractions and interruptions

Interruptions and distractions are some of the major contributing factors to errors during this stage (Hayes et al., 2015). Interruptions require nurses to stop the primary activity being carried out and incorporate a second activity, which leads to them managing a number of tasks simultaneously, while distractions such as noise can be processed with the primary task simultaneously (Cloete, 2015). However, these distractions may also contribute to and act as precursors to errors.

Interruptions and distractions may contribute to medication errors since they interfere with the knowledge and skill-based processes. Skill-based activities require the nurse to pay attention to the task at hand and interruptions can divert their attention and interfere with their performance. Knowledge-based activities depend on the conscious and analytical processes, which may be disturbed by distractions such as noise that may be hindered by competing demands (Cloete, 2015). Such distractions and interruptions compete for the attention of the nurse, interfere with the primary tasks and may result in errors during the process. Interruptions may occur due to the presence of another nurse, patients, technical sources such as alarms or from an operational failure of the devices being used (Cloete, 2015; Hung, Chu, Lee, & Hsiao, 2016). Interventions that could reduce the number and presence of distractions during medication administration would be useful in helping the nurses' focus on their primary tasks and reduce such errors from happening.

Nurse fatigue and workloads

Evidence indicates that the number of working hours and the length of the shift for nurses as well as heavy workloads contribute to nurse fatigue (Cloete, 2015). Nurses working under such conditions are more likely to be distracted at work, focus poorly on their activities, which may result in errors. According to Cloete (2015), nurses are 3 times more likely to commit errors when they work 12.5 or more hours in a shift. Also, nurses are 2.5 times more likely to suffer from burnout when they work shifts longer than 10 hours. In addition, the situation is made worse when these shifts occur at night since it leads to drowsiness and reduced cognitive functions (Hayes et al., 2015). Therefore, organizations should consider such factors in their investigation to reduce medication errors.

Reporting errors

It is essential to understand how errors occur, and this can be achieved by having reporting systems and mechanisms in medical facilities. In addition, error reporting is useful in determining the magnitude of the problem in the facility. This requires that the staff are aware of what constitutes a medication error and what needs to be reported. For instance, less than 20% of staff interviewed could identify a dose delayed by 45-60 minutes as an error (Cloete, 2015). Therefore, it is important to raise awareness among nursing staff through education and the dissemination of information about the necessity of reporting errors when they occur and educating the staff on what constitutes a medication error.

Quality Improvement Project

The project was designed as a quality improvement (QI) project which was linked to institutions' service delivery approach and system of care. A QI project was focused on the systems and processes of an organization/ facility with a focus on patients and on the use of data to improve the systems and processes. Organizations need to understand their delivery systems and key processes to improve the quality of care provided. This is done by focusing on what is done or the kind of care provided and on how it is done. In addition, a QI project should also focus on the use of data to describe the working of the systems in place and the need to apply changes to guarantee successful performance. Data is useful in comparing the performance across different systems and also in monitoring the impact and effectiveness of changes.

Based on the above definition, the project was a QI project since it is focused on the medication administration processes within the facility with a focus on the use of guardrails to reduce medication errors through the use of IV pumps, with an aim of improving practice and patient outcomes. Furthermore, the project was dependent on pre-collected data which consists of error reports and data from the software intervention. The aim of the project was to assess and evaluate the use of guardrails at the facility, and to optimize the uptake and use of guardrails in reducing medication errors.

Terms used

*Medication errors:*Preventable events which may cause or lead to the inappropriate medication use or patient harm, while the medicine is in the control of the health care professional, patient or consumer(Reddy et al. 2009).

Medication process: The process during which nurses administer medicine to patients.

Role of the DNP Student

The DNP program was a practice-focused program with the aim of preparing the student for practice in a complex health care environment. Through the program, it was expected that the student would develop and acquire competencies for increasingly complex practice, faculty and leadership responsibilities (AACN, 2006). For the success of the project, the DNP student was expected to act as a manager and delegate tasks and roles to the project team. The project had various components and the DNP student was expected to lead the team and allocate duties such as data collection and analysis to ensure that the project would run as designed. In addition, it was the duty of the DNP student to incorporate a multidisciplinary team to address the selected issue.

It is essential for health care professionals to function as collaborative teams to ensure safe and timely patient care (AACN, 2006). Therefore, the student needed to incorporate various professionals such as pharmacists and physicians in the project since they would have to share and provide invaluable insights that would help address the practice issues. As a nurse, safety is an important component of care and it was my responsibility as a DNP student to assess the impact of practice policies and procedures on meeting the needs of the patient. The project was a descriptive study to assess and evaluate the impact of guardrails on the medication administration process in a hospital setting. Therefore, it was the responsibility of the DNP student to analyze the policies and systems in place and to recommend quality improvement strategies that would be useful in creating and sustaining organizational and policy changes (AACN, 2006).

Summary

As seen, Kurt Lewins' change theory, Nightingales theory of environment and the Technology Acceptance Model are central to the practice project. When evaluating the use of guardrails in medication administration, it was important to consider the context in which the nurses work, and the QI project was useful in evaluating the implementation and use of the technology to determine the effectiveness of the guardrails. Section 3 describes the relevant data, the data collection methods and the statistical analyses that were employed to analyze the data.

Section 3: Collection and Analysis of Evidence

Introduction

Preparing and administering medication is an aspect of patient care, although it has the potential to result in adverse outcomes due to medication errors. Nurses are responsible for preparing and administering medicine, and errors can occur at any point in the process, due to various personal, environmental, and institutional factors. More than 450,000 medication errors occur annually in the United Kingdom, the United States, and Canada, resulting in fatalities and other unprecedented medical events (Hayes et al., 2015). The occurrence of such errors has been attributed to be due to various factors such as understaffing, working long shifts, fatigue among nurses, and the presence of distractions and interruptions in the environment (Hayes et al., 2015).The practice setting has instituted numerous approaches to address medication errors such as the use of barcode during medication administration. The issue of medication errors during drug administration is still an issue. The project was, therefore, aimed at assessing and evaluating the use of guardrails in reducing medication errors due to IV infusions.

The project was structured as a quality assurance project and it was useful in answering the research question: Was the implementation and use of guard rails during the administration of IV medication among nurses in a hospital setting effective in reducing the occurrence of medication errors? In this section, I introduce the practice focused question, describe the sources of evidence and the methods that were used to synthesize, and analyze the data.

Practice-Focused Question

Was the implementation and use of guard rails during the administration of IV medication among nurses in a hospital setting effective in reducing the occurrence of medication errors?

Sources of Evidence

The purpose of this quantitative, quality improvement project was to prevent medication errors,where data were collected from the error reporting system at the facility. The data consisted of error reports collected through the facility's error reporting system and stored within the organizations archives, as well as reports from the guardrails software. The project required institutional review board (IRB) approval, which was first obtained by seeking permission from risk management at facility, through the quality nurse manager. One this was obtained, the university evaluated the project based on the approval granted by the facility, the scope of the study, and the type of data collected and used. This was used to grant IRB approval.

The error reports consisted of reports before the implementation of the guardrails and those after the use of the technology, which were compared to determine the impact of the guardrails in reducing medication errors during IV infusion. In addition, reports from the guardrails software were used to determine the ease of use of the technology among the staff, and whether this had an effect on the occurrence of medication errors.

Archival and Operational Data

The data consisted of medication error reports voluntarily submitted at the facility by the staff involved in the event. The hospital had a reporting system that allowed for

staff to report when, where, and how such events occurred. The report included the name of the staff involved, although for the purposes of this study, no names were included in the reports. The data included the evidence of the occurrence of errors during the medication process. In many cases, some of these errors were reported and discussed with the unit managers, and they were used for educational and teaching purposes to address the issue of medication errors in the unit; they constituted reliable and valid data for the project.

In addition to the error reports, I also relied on reports from the guardrails infusion system. The reports were generated automatically by the system, and they provided information on the use of the system by the staff within the given period. To access the data, it was necessary to provide evidence for approval of the project, as well as to obtain permission from the organization, which allowed me to retrieve the data from the hospital's database.

Data Analysis and Synthesis

Data were collected, cleaned, and analyzed using the SPSSv.19 software. The level of significance was set at alpha 0.05 to reduce the occurrence of a Type 1 error. SPSS software was used to determine descriptive statistics of the data, such as the frequency distribution, percentages, and mean that were used to describe the occurrence of infusion errors. In addition to the descriptive analysis, *t*tests were carried out on the two paired samples. The ANOVA and *t*-test was used to compare between two observed means in the emergency department (ED) before and after a treatment is applied. The test

was useful in determining the effectiveness of the guardrails by comparing the occurrence of errors before and after the intervention.

Summary

The project was carried out as a descriptive quantitative design that involved data collection from hospital records. The data were analyzed through SPSS v. 19, which was useful in providing the frequency distribution of the data, as well as the ANOVA to identify the differences between the means. In Section 4, I will present the results of the data analysis.

Section 4: Findings and Recommendations

Introduction

Preparing and administering medication is an aspect of patient care, although it has the potential to result in adverse outcomes due to medication errors. The occurrence of such errors has been attributed to various factors such as understaffing, working long shifts, fatigue among nurses, and the presence of distractions and interruptions in the environment (Hayes et al., 2015).The practice setting had instituted numerous approaches to address the issue of medication errors. Medication errors during drug administration is still an issue. The project was, therefore, aimed at assessing and evaluating the use of guardrails in reducing medication errors due to IV infusions.

The project was structured as a quality assurance project and it was useful in answering the research question: Was the implementation and use of guard rails during the administration of IV medication among nurses in a hospital setting effective in reducing the occurrence of medication errors?

Practice-Focused Question

Was the implementation and use of guard rails during the administration of IV medication among nurses in a hospital setting effective in reducing the occurrence of medication errors?

The data consisted of error reports collected through the facility's error reporting system and stored within the organizations archives, as well as reports from the guardrails software. There was IRB approval and approval by the facility to provide access to the reports before the project was carried out.

The error reports consisted of reports before the implementation of the guardrails and those after the use of the technology, which were compared to determine the impact of the guardrails in reducing medication errors during IV infusion. In addition, reports from the guardrails software were used to determine the uptake and adoption of the technology among the staff and whether this had an effect on the occurrence of medication errors.

Data Analysis

Data were collected, cleaned, and analyzed using the SPSSv.19 software. The level of significance was set at alpha 0.05 to reduce the occurrence of a Type 1 error. SPSS software was used to determine descriptive statistics of the data, such as the frequency distribution, percentages, and mean that were used to describe the occurrence of infusion errors.In addition, the frequency distribution was useful in identifying the causes of errors, such as those due to organizational/ institutional factors or those due work environment factors (Agency for Health Care and Research Quality; AHRQ, 2017**).**In addition to the descriptive analysis, *t*tests were carried out on the two paired samples. The *t*test and ANOVA were used to compare two observed means of the same unit before and after a treatment was applied. It was useful in determining the effectiveness of the guardrails by comparing the occurrence of errors before and after the intervention.

Findings and Implications

Descriptive Statistics

According to the descriptive statistics,the minimum medical error reported was 0% while the maximum medical error reported was 15%. The mean value for the error report was 6.67% for the 9 years from which the data were obtained from. For the error report prior to the implementation of the guardrails, the mean error report was 13.33% for the years 2009, 2010, and 2011, with a minimum of 12% and maximum of 15% error report. After the implementation of the guardrails, the mean error report was reduced to 3.33% for the years 2012 through 2017 with a minimum error report of 0% and a maximum of 7% (Tables 1and 2).

Table 1

Combined Descriptive Statistics

	N	Minimum	Maximum	Mean		Std. Deviation	Skewness	
				Statistic	Std. Error	Statistic	Statistic	Std. Error
Medical Error Report (no of years)	9	0	15	6.67	1.841	5.523	.368	.717
Valid N (listwise)	9							

Table 2

Descriptive Statistics for the Medical Error Report Prior and After Guardrails Implementation

	N	Mean	Std. deviation	Std. error	95% confidence interval for mean		Minimum	Maximum
					Lower bound	Upper bound		
After	6	3.33	2.805	1.145	.39	6.28	0	7
Prior	3	13.33	1.528	.882	9.54	17.13	12	15
Total	9	6.67	5.523	1.841	2.42	10.91	0	15

Before the implementation of the guardrails, the medical error reports were 15%, 12%, and 13% for the years 2009, 2010 and 2011 respectively. After the introduction of the guard rails in 2012, the error report reduced to 7%; in the subsequent years, there was a steady reduction in the error reports. And as shown by the records, no reports/ data were available for 2018 (0%; Figure 1).

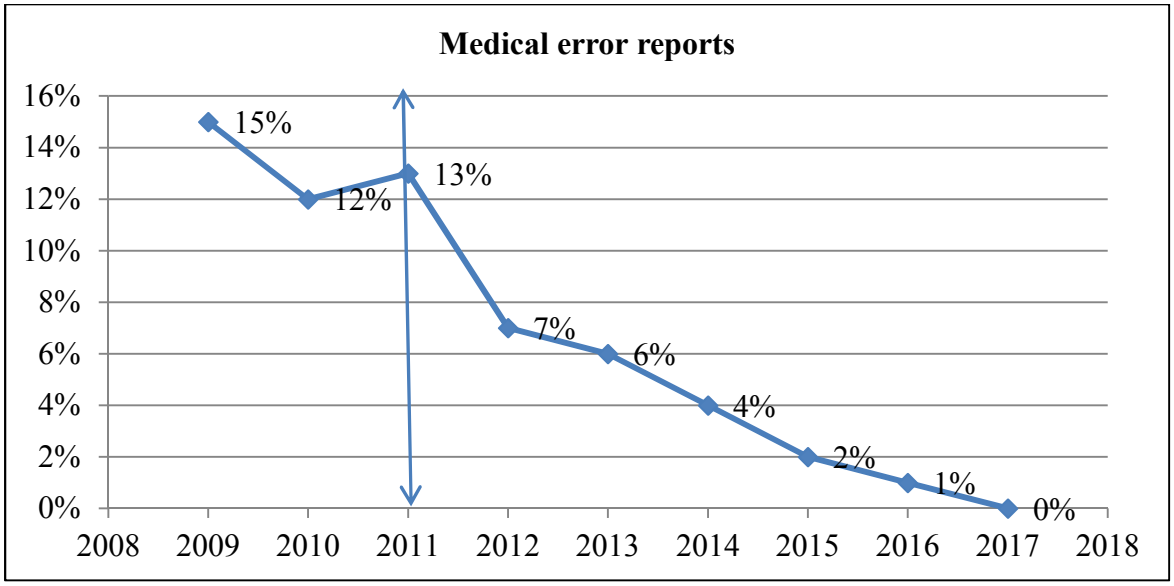

Figure 1. Medication errors prior and after implementation of guard rails.

Effect of Guard Rail Implementation on Occurrence of Medical Errors

From the ANOVA, the F statistic for the error report was 31.818, and$p \leq 0.001$. The *p*-value of 0.001 showed that there was a significant difference ($\alpha \leq 0.05$) between the use of guardrails and prior to their usage in affecting the occurrence of medical errors, as shown in Appendix: A. The implementation and use of guardrails during the administration of IV medication among nurses in a hospital setting effective in reducing the occurrence of medication errors (Table 3).

Table 3
ANOVA Table

Sample: 9 years	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	200.000	1	200.000	31.818	.001
Within Groups	44.000	7	6.286		
Total	244.000	8			

The *t*test analysisshowed that the mean value for error report prior to guardrails implementation was higher (13.33%) compared to the error report after the guardrails implementation (3.33%).The *t* value was -5.641 with a*p*-value of 0.001, showing that there was a significant difference between the medical error report prior and after the implementation of the guardrails. Because the group statistic revealed that the mean of error report prior to guardrails implementation is greater than that after implementation, it can be concluded that the introduction of guardrails resulted in significant reduction of medical errors among the nurses in the hospital (Tables 4 and 5).

Table 4
TtestGroup Statistics

	Guardrails	*N*	Mean	Std. deviation	Std. error mean
Error report	After	6	3.33	2.805	1.145
	Prior	3	13.33	1.528	.882

Table 5

Independent Samples Test

		Levene's test for equality of variances		*t*test for equality of means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean difference	Std. error difference	95% confidence interval of the difference	
									Lower	Upper
Medical Error Report	Equal variances assumed	2.741	.142	-5.641	7	.001	-10.00	1.773	-14.192	-5.808
	Equal variances not assumed			-6.919	6.752	.000	-10.00	1.445	-13.443	-6.557

Guardrails Performance

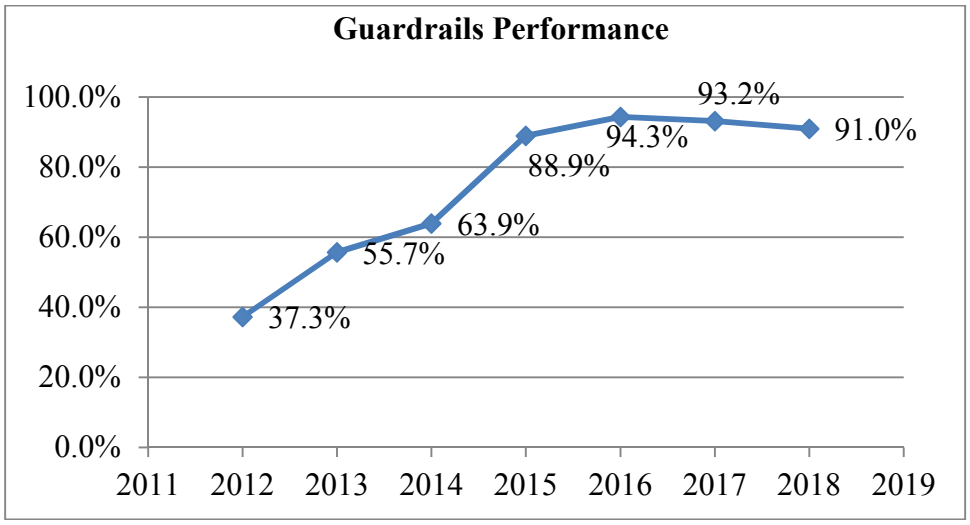

*Figure 2.*Guardrails performance since introduction and implementation.

When the guardrails were introduced in 2012, the performance scorecard was 37.3%. Its performance then gradually increased in the years following its introduction; in 2016, it recorded a performance level of 94.3 % translating to 154% improvement since 2012 (Figure 2, Appendix B). The nurses at the hospitals were getting more acquainted with the use and operation of the guardrails. This performance improvement could explain the reduction in the cases of medical errors among the nurses in the hospital. It could be used to explain technology acceptance at the facility, indicated by the ease of use and the efficiency of use. Increased acceptance of the technology translates to better use by the staff which results into reduced medication errors when administering IV medication.

Potential Implications

From the study, the implementation of the guardrails at the facility had a significant impact in reducing the rate of error in the administration of medication through the use of IVs. It is possible that the findings could be replicated in similar facilities and address the issue of medication errors and improve service delivery and patient outcomes. The project has also shown the need for more extensive studies that explore the social effects of having such interventions on the workplace on both the staff and the patients. For example, it would be useful to explore whether the guardrails have increased the confidence of the nurses during medication administration, or even of the patient receiving the medication, as well as other social factors.

Recommendations

Based on the findings of the study, it is recommended that the facility continue using the guardrails that are useful in collecting the error reports that will be used to guide further action by the facility. Further, there may be room/ potential at the facility for more interventions to reduce the occurrence of errors and improve service delivery and patient outcomes. For example, there is the potential to upgrade to a more sophisticated system that has more preventive features that will further reduce the risk of medication errors.

Strengths and Limitations of the Project

This project provided data that shows the effectiveness of the guardrails in reducing medication errors in the facility. The quantitative data derived from the project will be useful in informing other facilities on whether or not to implement the same

technology in their operations. There is room to build up the project by exploring whether the guardrails have resulted in any other benefits to the facility, such as a reduction in costs due to reduced medication errors.

Section 5: Dissemination Plan

The findings of the study will be disseminated through the use of Power Point presentations and posters at the facility. The presentations will be structured and scheduled to ensure that every member of the facility has an opportunity to sit through the presentations. The advantage of the Power Point presentations is that they can be modified to accommodate the audience ranging from the medical to nonmedical staff. Posters will be created and pinned in areas of direct vision within the facility to guarantee maximum exposure. In the posters, I will indicate the benefits of adhering to the guardrails and encourage the staff to use the technology. The findings will be disseminated to the staff and they will have impact on practice at the facility.

Apart from the study site, the findings of the project will also be relevant to other practitioners/ professionals. The findings can be disseminated in professional conferences, such as the 2018 American Nurses Association (ANA) quality and innovation conference or seminars, where colleagues can get a chance to listen to my presentation or read the poster. It may also be possible to publish a research paper in a peer-reviewed journal that may validate and authenticate the study and reach a wider audience.

Analysis of Self

As an individual, it is important to ensure that I present the findings in a way that is acceptable and that will encourage cooperation in the use of the guardrails. It is important to recognize my role as a scholar-practitioner, where I have generated new evidence that will guide practice, which makes me an authority in the field. It will also

place me as a leader due to my ability to participate in and disseminate scholarly work in the workplace and also to provide leadership in implementing the recommendations. I have influence both from my work and from my position, which will influence the dissemination and uptake of the results.

The project has opened me up to collaboration and cooperation with my colleagues, and it has shown the need for collaboration in the research process. The main challenge was in the analysis of the data, which I handled by consulting with statistical experts that helped in analyzing and interpreting the findings. In the long-term, I hope to be more involved as a scholar-practitioner and contribute to quality improvement in the workplace to improve working conditions and contribute to improve patient outcomes.

Summary

The aim of the project was to evaluate the use of guardrails at the facility and their significance in reducing medication errors when administering IV medication. The project was structured as a quality improvement project where error reports from the guardrail software were collected and analyzed, and I compared with data before the intervention. I found that the implementation of the guardrails had a significant effect in arresting and reducing medication errors. The project was successful in identifying the significance of the guardrail software at the facility and in emphasizing the role of such interventions in improving service delivery and patient outcomes.

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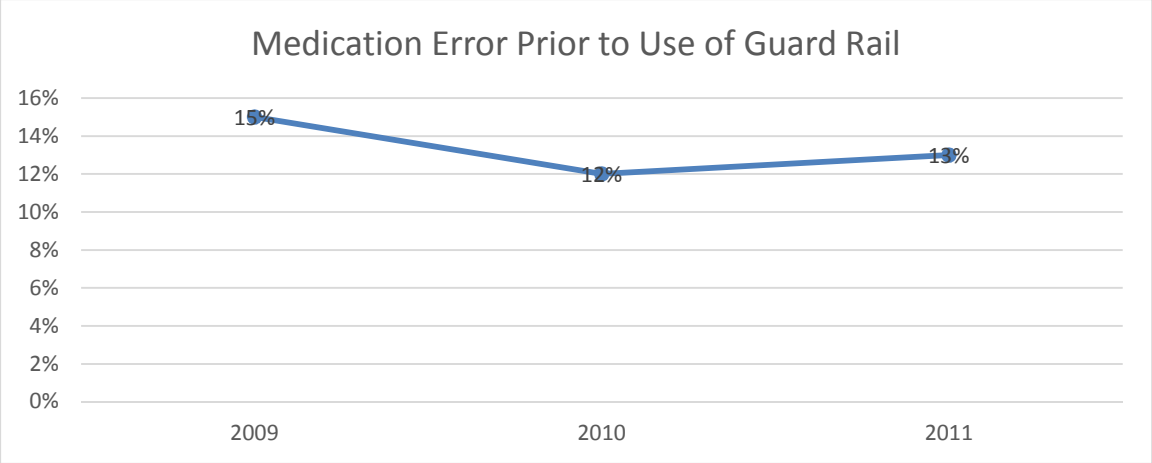
Appendix A: Medication Errors Prior to the Implementation of Guard Rails



Appendix B: Error Reports after the Implementation of Guard Rails