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Root Cause of Medication Errors In a Pediatric Intensive Care Unit

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Abstract

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MSN/MBA, University of Phoenix, 2012

BSN, Mercy College, 2007

Project Submitted in Partial Fulfillment

of the Requirements for the Degree of

Doctor of Nursing Practice

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Abstract

Five to 27% of all pediatric medication orders lead to errors and play a significant role in the morbidity and mortality of the pediatric patients admitted to hospitals. The practice problem explored the high rate of medication errors in the pediatric intensive care unit (PICU) of the project site, where the population is particularly vulnerable due to their acute illnesses. The purpose of this project was to analyze the root causes of all cases of medication error in this hospital's PICU during the last 2 years. The literature review was used to categorize secondary data extracted from the hospital's quality assurance database. An analysis of the 41 total medication errors showed that 49% of the medication errors made in the PICU were due to the nurse administering the incorrect dose of medication. Most (60%) occurred on the day shift when the unit was busy and the patient's medication orders were constantly being changed. Missed doses—mostly due to oversight and ineffective follow-up by clinical staff, pharmacy, and providers--accounted for 27% of the medication errors. There were instances in which the physician and the pharmacy did not properly order and verify a medication. The summary of the root cause analysis and recommendations from the literature for improved clinical practice will be presented through the hospital's quality assurance structure. Recommendations include implementing computerized physician order entry, regular education of staff, involvement of the pharmacist in new medication orders, updated nursing protocols, and support systems for decision making. The implications of this project for positive social change include the impact of improved practices on decreasing medication errors and improving health outcomes in the PICU population.

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Dedication

This project is dedicated to my father, Gilbert Louis Tingling, who died on Palm Sunday of 2017 just as I was about to start this project. Completing this DNP program was our goal and my dream of having him in the audience when I receive my doctorate degree. I would also like to dedicate this project to my family for being so patient and understanding as I spent countless nights in the family basement preparing for this special day. This degree will serve as an inspiration to the staff and friends that I have met and are currently practicing in this profession. Finally, to my sister Christine who has been my rock and role model over the years. I have proudly followed in her footstep as a nurse and she has always been there with me every step of the way.

Acknowledgments

I would like to take this time to acknowledge my wife and five children Shantel, Louis Jr., Dominique, Alexander, and Samantha. My four grandchildren Aden, King, Avery and Amorie, you have all inspired and motivated me to complete this program. I would also like to acknowledge my chair Dr. Catherine Garner for all her support, guidance, and steady leadership through this process. Finally, a special thank you to my good friend, mentor and preceptor Dr. Veronica Thompson and the entire team at the medical center for giving me the opportunity and support to complete this project.

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Section 1: Nature of the Project

Introduction

Medication errors (ME) play a significant role in the morbidity and mortality of the pediatric patients admitted to hospitals, resulting in hundreds of injuries, deaths, and disabilities every year (Rinkel et al., 2014). Medication errors account for 7,000 patient deaths annually in the United States, with a three times greater risk in pediatric patients (Rinkel et al, 2014). Five to 27% of all pediatric medication orders lead to errors (Rinkel et al., 2014). Children may be at particularly increased risk for ME due to varied physical characteristics, stages of development, communication barriers, and treatment by health care staff unfamiliar with this age group (Neuspiel & Taylor, 2013). Determining the causes and types of these errors can help address the safety of the patients in the pediatric intensive care units (PICU).

Considering all possible types of health care errors, several studies evidenced that MEs are the most common. MEs have been focused on by professionals, institutions, and health authorities due to their contribution to increased morbidity, length of hospital stays and health system cost, and the impact on the safety and quality of patient care (Belela, Peterlini, & Pedreira, 2010). Although errors form an integral part of human lives, every error that occurs in the everyday lives of a human being has a cause. Establishing these causes may present either a temporary or permanent solution that will lead to a reduction of these errors (Belela, Peterlini, & Pedreira, 2010). Errors may originate from the natural processes of behavioral and cognitive adaptations resulting from developed behavioral skills (Belela, Peterlini, & Pedreira, 2010). Implementation of orders in the

medical field is a primary component of nursing as well as ensuring the safety of the patients. Nurses assume the final responsibility for administering the correct medication and dosage (Karavasiliadou and Athanasakis, 2014).

The purpose of this capstone project was to perform a detailed analysis of the root causes of all cases of ME in this hospital's PICU for the past 2 years. The findings from this analysis framed the report to the pediatric quality committee, which included best practices cited in the literature for consideration and adoption. Decreasing ME through evidence-based practice in this high-risk setting may improve the safety of the medication system, nursing practice, and the health outcomes of pediatric patients.

Problem Statement

The PICU is a key target for quality improvement due to the complexity of care and the potential for medical errors in the setting. Medication errors lead to increased morbidity and mortality rates in children (Rinkel et al. 2014). The PICU at this medical center has experienced an increase in medication errors and near misses over the past 2 years according to the pediatric quality committee quality reports. This 26-bed acute unit offers care to a variety of children with different types of acute illness ranging from asthma, cardiac, liver, kidney transplant, neuro-surgery, and general surgery. Current quality practices in this pediatric unit have been ineffective in reducing the errors, thus creating the need to establish better and more efficient practice. Children, especially young, small, and sick children are usually less able to physiologically tolerate a medication error due to their inability to communicate effectively to providers regarding any adverse effects that medication may cause (The Joint Commission, 2010).

Pediatric intensive care units are a key area for national patient safety efforts. One study reviewed more than 1,000 errors in medication and found there were more than 150 errors in prescribing medication in one hospital's pediatric intensive care unit (Glanzman, Frey, Meier, & Vonbach, 2015). The study found 70% of the errors caused harm to the patient and needed interventions (Glanzmann et al., 2015). Another study revealed a 48.8% error rate in 512 drug doses, and many were administration errors, such as managing the drugs and giving then on time (Haghbin, Shahsavari, & Vazin, 2016). Monitoring is the most common type of error found in several studies.

Kiani (2017) reported that 50 to 70% of harm from pediatric medication errors can be prevented by using a comprehensive systematic approach to patient safety. The most common errors in pediatrics were the wrong dose/quantity, omissions, wrong drug, prescribing error, wrong administration technique, wrong time, wrong route, and wrong dosage form (Kiani, 2017). Human error was found in 80% of adverse events to the patient's health (Kiani, 2017). A study found that 11.1% of adverse drug events happen in pediatric patients (Kiani, 2017). Evidence reveals that 22% of adverse drug events can be prevented, almost 18% could have been identified earlier, and almost 17% could have been treated more effectively (Kiani, 2017). Twenty to fifty percent of all antibiotics prescribed in acute care hospitals are either inappropriate or unnecessary (Kiani, 2017).

The most commonly reported errors in PICUs include computation errors of dosage and dosing intervals, inappropriate medication for the condition being treated, incorrect dosage or frequency of administration of medication, wrong route of administration, failure to recognize drug-drug or drug-herbal interactions, lack of

monitoring for adverse drug effects, missed/ late dose errors, and inadequate communication between the physician and other members of the healthcare team, the parent or caregiver (American Academy of Pediatrics, 2010). Key factors that influence errors include dosing errors, the use of off-label indications, poor reviewing of orders and prescriptions by pharmacists, and the nurse's inability to detect errors (Rinkel et al., 2014). Hence, identification of these factors helps nurses to reduce errors and helps reduce other medical consequences and improve in the quality of patient care and patient safety (Rahimi, Rezei, Baghaei, & Feizi, 2015). The philosophy of pediatric nursing care is the provision of care by focusing on the family, providing atraumatic therapeutic care, and using evidence-based practice (EBP; Perspective of Pediatric Nursing, 2012). In the PICU, EBP standardizes practices which can deliver more predictable outcomes (EBP; Perspective of Pediatric Nursing, 2012). Despite the provision of different safety priorities and intervention measures, medication errors continue to be a key problem in this healthcare setting.

Purpose Statement

The purpose of this quality improvement project capstone was to examine the root cause for medication errors in the PICU and then recommend changes to interprofessional policies and procedures based on best EBP literature. The gap in current safe medication practice is demonstrated through the high number of medication errors and near-misses in this PICU over the last 2 years. The American Academy of Pediatrics (2018) argued that reducing pediatric medication errors is a collaborative effort. It cannot be done by just one person. Many of the mistakes are preventable. The following practice

focused question guided the project: Will the analysis of specific data associated with medication errors and near misses pinpoint the key areas that should be addressed using evidence-based practice?

The analysis should help to understand the specificity and contributing factors for medication errors in the PICU. No single policy or procedure has worked universally to reduce and eliminate these errors. This means that each facility needs to adopt policies and procedures that all staff, including nurses, can perform that will decrease the number of errors with the goal of eliminating all medication errors. Needing slightly different procedures for the medication team and nurses between hospitals is not uncommon. Using the data analysis, the team can then modify their changes to better fit the needs of their hospital. Further, the procedure or policy must fit the specific types of errors being made in that specific PICU. There would be different tactics for the error of overdosing and the error of ordering the wrong drug. As an example, Manias, Kinney, and Cranswick (2014) conducted a meta-analysis to find the interventions that worked to reduced medication errors in pediatric intensive care units. They decided on 34 articles on the topic (Manias et al., 2014). Six types of interventions were included in the reports: (a) computerized physician order entry; (b) intravenous systems; (c) modes of education; (d) protocols and designs, (e) pharmacist involvement, and (f) support systems for clinical decision-making (Manias et al., 2014). Results suggested that computerized physician order entry, education, and support systems for decision making were helpful in reducing the number of medication errors in the PICU (Manias et al., 2014).

Hospitals need to have accepted pediatric standards in terms of dosing and limits in emergency and PICU, including having a standard pediatric formulary with specific standard dosing. The medical staff would benefit from seamless education and training as well as practice patterns for prescribing the high-risk medications (American Academy of Pediatrics, 2018). The following ideas for standards in providing medication to pediatric patients have been tested in various settings. Some of the recommendations are adopt computer physician ordering, develop a standardized formulary that will provide ongoing training and education in drugs, and be sure that all prescriptions are okayed by pharmacists (Benjamin, Frush, Saw, & Shook, 2018). Pharmacists know the latest information about drugs, how they are used, and potential problem situations (Benjamin, Frush, Saw, & Shook, 2018). Training is critical in all medications, but children are at higher risk than adults. These steps can close the gap between theory and practice as well as the gap between patient safety and patient risk. Medication errors in PICUs are not something that can be left or ignored; steps must be taken to eliminate these errors. The PICU treats children in critical conditions, and any service rendered to them must be of utmost accuracy to avoid further complications. The administration of drugs to the pediatric patient may affect his/her tissues leading to differences in the absorption effects (Ferner, 2009). Pediatric patients can experience muscle wasting and must be handled with a lot of care to prevent further complications (Ferner, 2009). Thus, a lack of monitoring the conditions of the patients like the core temperatures of the patients and their states contributes to the risk of excessive drug release and usage.

Nature of the Doctoral Project

This quality improvement capstone project involves a secondary data analysis of adverse event data collected from the quality and safety department on medication errors in the PICU over the last 2 years. Using the Institute for Quality Improvement root cause analysis tools, I categorized the data into (a) physician prescription, (b) pharmacy transcription of orders, (c) pharmacy preparation of medication, (d) transportation and stocking of the medications, and (e) nursing administration of the medication.

A second analysis of data by category examined whether the errors occurred because of system issues or human factors and the specific circumstances that contributed to both. Nursing workload is increasingly thought to contribute to quality/ safety of care (Holden et al., 2015). In addition, human beings are error prone, which increases the risk of medication errors in the PICU. Human factor strategies target the reduction of errors involved in designing systems, processes, work environment, and technology that recognize human fallibility (Gluyas, & Morrison 2014). Some examples of these strategies are avoiding reliance on memory and having protocols and evidence-based resources readily available for practitioners to check their knowledge (e.g. written or electronically) (Morrison, 2014). Resources should be easily accessible with a culture that encourages the use of such resources (Gluyas, & Morrison 2014). Another strategy is to increase the individual's awareness of human fallibility, which can highlight situations where the potential for errors is increased, and then challenge the individual to assess frequently which factors are present that might increase the potential for error (Gluyas, & Morrison 2014). In order to decrease the human factor in medication errors will require

everyone, including frontline staff, administrators, and stakeholders, to be fully vested, transparent, and a contributor to a climate of just culture

This project employed categories and frequency assessment in analyzing the evidence from the data collected. The data gathered was extracted by the quality manager, de-idetified, summarized in categories, and put into an appropriate framework to present the data. This project followed the ordinary course of identifying similar data which will lead to common information.

Significance

Identifying and including all the stakeholders in any given project is vital for progress and success of the initiative. Stakeholders include the clinical nursing staff, physicians, primary care doctors quality improvement staff and pharmacists and their staff. The stakeholder's support is an essential requirement and an integral part of planning, development, evaluation, and implementation of processes, projects, and plans for any institution.

Medication errors in children can increase mortality and morbidity, thus safe medication administration and preventing medication errors is an important concern and applicable to practicing nurses. Nurses administer medication in inpatient health care settings and serve as the last line of defense in preventing medication errors McGinley, 2009). Medication errors can be significantly reduced by understanding the prevalence, care processes, and contributing factors of errors (McGinley, 2009). This doctoral project is important to the facility and the positive social change in pediatric nursing because of the high rate of medication errors and the patient harm associated with medication errors.

Administration of drugs has challenges that must be addressed to reduce the adverse effects. These effects are results of medical errors that may arise during the formulation and administration of these drugs. However, several positive social changes are projected to occur due to this doctoral project after establishing the cause of the medical errors in the PICU. Some of the positive changes that may arise include labeling of medication and solutions to other route specific problems related to the formulation design of drugs. Under medication labeling, the healthcare personnel has often encountered difficulties in liquid medication caps, medication vials, packing of drugs with similar labeling fonts, color schemes used within the hospital setups, font sizes, and the intravenous (IV) drug bags (Kaushal, Bates, Abramson, Soukup, & Goldmann, 2008). These medications have similar appearances, labeling, and are often confusing to the medical personnel (Kaushal, Bates, Abramson, Soukup, & Goldmann, 2008). The confusion brought by the similarity in these medications are often of the utmost concern while dispensing and administering the drugs and are usually the cause of the medication errors experienced in the PICU. Containers across various products lines within a hospital setup have often been designed similarly for distinction purposes; however, this has been the source of confusion for the medical personnel (Alvarez & Coiera, 2006). Nonetheless, different products or vial sizes ought to be distinguishable using their shapes, colors, sizes, and other mechanisms to avoid confusion. Labeling of products spans across almost all administration roots; it includes medication guides, marketing materials, packaging of the products and package inserts. Labelling is considered a social issue due the different formulations of the same drugs, look-alike/sound-alike drug names, multiple abbreviations within the hospital

setup, unclear designations of the dose strengths, confusing abbreviations and symbols, cluttered labeling, lack of an accurate terminology in for the administration of drugs, and inadequate prominence of warnings within the packaging's of drugs (Stefan, 2012). Labeling as a social issue has played a critical role that has led to serious medication errors.

Apart from labeling, there is another root specific problem associated with the modes of drug administration that have brought several implications because of the social changes arising while trying to establish the main cause of the medical errors in the pediatric intensive care units (Wall & Cooper, 2012). Associated issues related to these administration modes, such as medications that are only available in a given formulation, are often encountered frequently in critical care (Wall & Cooper, 2012). An example of such drugs is the carbidopa that is only available in a given formulation. Pediatrics suffering from diseases such as Parkinson's disease who are often admitted to the intensive care units with strict NPO orders often have no options but to use enteral drug administration mode to receive this critical medication (Kaushal et al., 2001). The use of subcutaneous route in drug administration also has various implications, as it requires a lot of accuracy in drug administration (Garber, Gross, & Slonim, 2010). Health care providers giving subcutaneous injections to pediatrics must be knowledgeable and experienced considering the delicate nature of the children they are dealing with. The level of injection determines the absorption rate of the administered drugs, its duration of action, and the onset of its effectivity (Garber, Gross & Slonim, 2010). Drugs administered deep into the muscles take longer to take effect as opposed to those given in

the subcutaneous layer (Garber, Gross, & Slonim, 2010). Differences in the injection layers can lead to several complications that can be difficult to treat. (Garber, Gross, & Slonim, 2010).

The potential social significance is that identification of the root cause of system and practice errors can lead to the adoption of best practice in the pediatric intensive care unit, improving the outcomes of critically ill pediatric patients.

Summary

Medication errors in the PICU plays a significant role in the mortality and morbidity of the patients admitted (Vazin, 2016). Research shows that the potential for adverse drug events within the pediatric inpatient population is about three times as high as among hospital adults (Rinke et al, 2014). Most of these medication errors are preventable. This project focused on establishing the root causes of the medication errors within the PICU using the IHI root cause analysis tool and a human factor analysis. Section 2 will discuss the concepts and theories, the relevance to nursing practice, and the role of the DNP student.

Section 2: Background and Context

Introduction

A medication error can occur at any one of a number of places in the medication process. Medication errors can stem from prescribing, transcribing, dispensing, or administration. These kinds of errors cause at least one death every day and injure more than a million people every year (Trakulsunti & Antony, 2018). Although this has been a known problem for many years, health care managers have not yet found a process or procedure to eliminate these kinds of errors. As Karavasiliadou and Athanasakis (2014) put it, the medication process begins with the physician's decision regarding which medication to use and how it needs to be administered and ends with the nurse giving the patient the medication.

Considering all possible types of health care errors, several studies show evidence that medication errors are the most common. Medication errors have been focused on by professionals, institutions, and health authorities due to their contribution to increased morbidity, length of hospital stay and health system cost, and the safety and quality of patient care (Belela et al. 2010). Although errors form an integral part of the human lives, every error that occurs in the everyday lives of a human being has a cause. Establishing these causes may present a solution, either temporary or permanent, that will lead to a reduction of these errors. Errors may originate from the natural processes of behavioral and cognitive adaptations resulting from developed behavioral skills (Belela et al. 2010). Execution of orders in the medical field is critical towards the healing process and the care provided for patients. Implementation of orders in the medical field is a primary

component of nursing as well as ensuring the safety of the patients. Nurses assume the final responsibility for administering the correct dosage and medication (Belela et al. 2010).

The purpose of this capstone project was to perform a detailed analysis of the root causes of all cases of medication error in this hospital's pediatric intensive care unit for the past 2 years. The practice focused question is "Will the analysis of specific data associated with medication errors and near misses pinpoint the key areas that should be addressed using evidence-based practice." The results from this analysis framed the report to the pediatric quality committee, which will include best practices cited in the literature for consideration and adoption. Decreasing medication errors through evidence-based practice in this high-risk setting may improve the safety of the medication system, nursing practice, and the health outcomes of pediatric patients. Section 2 includes a discussion of the background and context for this analysis.

Concepts, Models, and Theories

Miller, Haddad, and Kenneth (2016) stated that in the United States medication errors sicken, injure, or kill 1.5 million patients every year, of which at least 400,000 were preventable. These errors increase medical costs by about $3.5 billion (Miller, Haddad, & Kenneth, 2016). The errors made in the PICU have a negative impact on everyone: the child suffers in terms of his or her health, including some fatalities; the nurse feels extremely guilty and suffers extreme emotional and psychological pain, and the family suffers psychological damage (Miller, Haddad, & Kenneth, 2016).

The American Academy of Pediatrics (2018) argued that reducing pediatric medication errors is a collaborative effort that cannot be done by just one person, and many of the mistakes are preventable. Pediatric patients are at high risk for having medication errors for many different reasons. Weight-based dosing, for example, is high risk in itself (American Academy of Pediatrics, 2018). Verbal orders can get lost in the noise.

Ayanian and Markel (2016) asserted that the contemporary health care quality movement had its beginning in 1965, which was shortly after the Medicare and Medicaid programs were established. A meeting of leaders in health-related fields was convened (Ayanian, & Markel, 2016). This group looked at the influence of social and economic research on health agencies as well as the quality of care (Ayanian, Markel, 2016). Donabedian 1966 was one of those experts and his work on theory and practice of quality assurance helped form the emerging field of health services research (Ayanian & Markel, 2016). Donabedian proposed using a triad or three-prong approach including structure, process, and outcome to evaluate and investigate the quality of health care (Ayanian & Markel, 2016).

Structure was described as the settings where the health care was taking place along with the qualifications of the healthcare providers and administrative systems (Ayanian & Markel, 2016). Process was described as the components involved in providing care (Ayanian & Markel, 2016). Outcome was defined as restoration of functions, recovery, and survival (Ayanian & Markel, 2016). These concepts are still viewed as the foundation of quality assessment.

The following provides samples of activities that would fit into each of the three arenas. Structure is comprised of infrastructure, demographics, technology, education, and facilities (Lighter, 2015). Process includes diagnosis, treatment, appropriateness, process of care, and resource requirements (Lighter, 2015). Outcomes include mobility, mortality, cost, factors creating cost, and quality of life (Lighter, 2015).

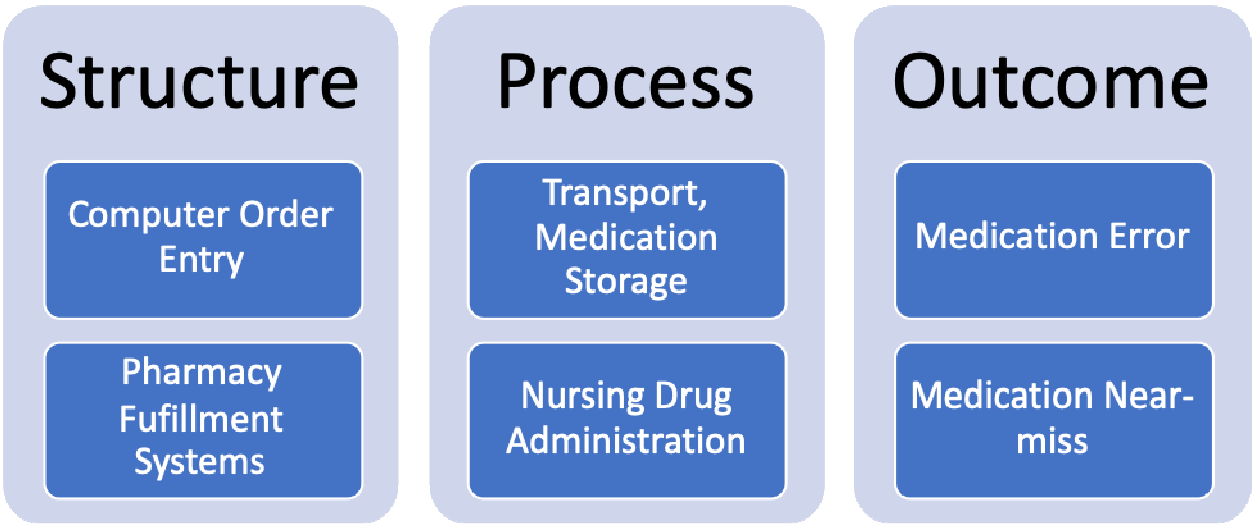

Figure 1. Donabedian 1966 Quality Assurance Model

Manias et al. (2014) conducted a meta-analysis study to review the interventions that worked to reduced medication errors in pediatric intensive care units. They ultimately selected 34 articles on the topic that met their criteria (Manias et al. 2014). Six types of interventions were included in the reports: (a) computerized physician order entry; (b) intravenous systems; (c) modes of education; (d) protocols and designs; (e) pharmacist involvement; and (f) support systems for clinical decision-making (Manias et al. 2014). Results suggested that computerized physician order entry, education, and

support systems for decision making were beneficial in reducing the number of medication errors in the pediatric ICU (Manias et al., 2014).

Meta-analyses have been done to discover interventions and strategies to eliminate medication errors (Manias et al., 2014). These researchers found that computerized prescription ordering by the physician, pharmacist involvement, education, and support systems for clinical decision making all led to statistically relevant reductions in pediatric medication errors in a PICU (Manias et al., 2014). A pharmacist was brought into at least one of the studies (Manias et al. 2014). The clinical pharmacist's job was to review medications on a pediatric unit. The researchers found that having a pharmacist review the medications, the symptoms, and the diagnosis reduced the number of errors made on PICU (Manias et al. 2014). This makes sense because pharmacists typically know what changes have been made in different medications. Hospitals need to have accepted pediatric standards in terms of dosing and limits in emergency and ICU. Having a standard pediatric formulary with specific standard dosing, the medical staff would benefit from seamless education and training as well as practice patterns for prescribing the high-risk medications (American Academy of Pediatrics, 2018).

The following ideas for standards in providing medication to pediatric patients have been tested in various settings. Some of the recommendations are adopt computer physician ordering, develop a standardized formulary that will provide ongoing training and education in drugs, and be sure that all prescriptions are okayed by pharmacists. Pharmacists know the latest information about drugs, how they are used, and problems situations (Benjamin, 2018; Efstratios, 2017). Implementing the suggestions above results

in greater training. Training is critical in all medications, but children are at higher risk than adults and their care givers need more training (Benjamin, 2018; Efstratios, 2017). PSNet (2017) reminds people in the profession to remember the five rights of medication safety: administer the right medication, in the right dose, at the right time by the right route, to the right patient (PSNet, 2017).

A study reported by Trakulsunti and Antony (2018) demonstrated that Six Sigma could reduce mediation errors, increase patient safety, and reduce operational costs. Many health-care organizations have adopted Six Sigma with favorable outcomes such as reduced emergency room cycle time, increased timely completion of medical records, and reduced medication errors (Trakulsunti & Antony, 2018). Lean is another process that has had success in reducing medication errors and reducing costs (Trakulsunti & Antony, 2018). Lean and Six Sigma tools used together have even better results (Trakulsunti & Antony, 2018). The trick is to adopt the proper tools to use with a specific facility.

Root Cause Analysis

The root cause is what underlies the problem (AHRQ, 2018). Root cause analysis is a method or strategy to identify the underlying causes of an event or issue so that an appropriate solution can be designed and implemented (AHRQ, 2018). Applying this theory to medication errors in the PICU, the outcome or consequence would be seen on top and visible while the root causes are not necessarily visible. Root cause analysis, then, is the act of discovering the causes for the event. Three questions would be asked:

"What's the problem? Why did it happen? And what will be done to prevent it from happening again?" (AHRQ, 2018).

After searching and studying the literature, it has been discovered that the most common errors in pediatrics were the wrong dose/quantity, omissions, wrong drug, prescribing error, wrong administration technique, wrong time, wrong route, and wrong dosage form. Human error was found in 80% of adverse events to the patient's health (Kiani, 2017). A recent study by Kiani (2017) found that 11.1% of adverse drug events happen in pediatric patients. Evidence reveals that 22% of adverse drug events can be prevented, almost 18% could have been identified earlier and almost 17% could have been treated more effectively (Kiani, 2017). One very surprising statistic was that 20-50% of all antibiotics prescribed in acute care hospitals are either inappropriate or unnecessary (Kiani, 2017).

Another study took a hint from a different field (business) and combined a Six Sigma and Lean, which was called Lean Six Sigma (Nesupiel & Taylor, 2013). Using these processes and concepts, medication errors can be reduced but it will depend completely on which Lean and Six Sigma tools are used. Nesupiel and Taylor (2013) conducted a MEDLINE study that included nearly 20 years of data. They found that pediatric interactions with medication were in emergency rooms, clinics or offices (Nesupiel & Taylor, 2013). They identified the percentage of errors in each venue. In the emergency room, they found 10% underdoses and 12% overdoses for acetaminophens (Nesupiel & Taylor, 2013). Glanzmann et al. (2015) were investigating the types of medication errors made with critically ill children. The greatest numbers of errors (50%)

were made with antihypertensive, antimycotics and drugs for nasal preparation. All in all, 70% of the medications had errors (Nesupiel & Taylor, 2013). Hughes (2008) argued that errors mean there is a system error, something is wrong in part of the system. Others have noted there are a lot of medication errors in administering.

Efstratios (2017) presented his research on protective measures nurses can take to prevent medication errors. Strategies included using labels, reducing distractions, using a calculator, double-checking always, educating nursing candidates, being especially careful when orders are given over the phone, and nursing administrators overseeing the process (Esstratios, 2017). Izadpanah, Kashani, and Sharif (2015) also reviewed numerous reports and studies and noted that one idea to reduce errors was to have medicine that is specifically for children labeled as such. Glanzmann et al. (2015) noted that in their study 104, or 70%, of the errors were identified as medication prescribing errors. Izadpanah et al. (2015) noted that out of 200 mistakes, 69.9% were pediatric patients. They also noted that a different dosage of the identical medicine was one of the major culprits for errors in their study (Izadpanah et al. 2015). That means there were different parameters for the medicine.

The articles all noted that medication errors can be prevented. It is just a matter of having standards that all people follow. Rinke et al. (2014), for instance, reported that studies of computerized provider order entry with clinical decision support compared to studies without clinical decision support reported a 36-87%reduction in prescribing errors. There was also a significant reduction in prescribing errors, 27-82%, when preprinted order sheets were used (Rinke et al., 2014).

Human Factor Analysis

The term 'human factors' has gained popularity in articles but there is misunderstanding about the definition. In fact, Russ et al. (2013) said their growing confusion about human factors science in both the scientific and in anecdotally literature. Misunderstanding can easily lead to negative outcomes. Human factors meet at the crossroad of psychology and engineering. It is dedicated to designing all aspects and components of a work system to support human safety and performance. Human factors are also referred to as ergonomics. It uses scientific approaches and methods to prevent harm while it improves performance. There are two goals in human factor science: one goal is to "support the cognitive and physical work of healthcare workers and the other goal is to promote high quality, safe care for patients" (Russ et al., 2013).

The term 'human factors' could also be defined as enhancing clinical performance through an understanding of the effects of teamwork, tasks, equipment, workspace, culture, organization [sic] on human behavior and abilities, and application of that knowledge in clinical settings" (Huynh et al., 2017, p. 102). Giving the wrong medication causes the patient harm while it also causes psychological harm to the nurse who makes a mistake. They also cause a great deal of psychological harm to the nurse who makes a mistake. They blame themselves; they accept responsibility, they fear the consequences, they fear criticism and given these negative outcomes, they may be less willing to report future mistakes (Huynh et al., 2017).

A medication error can occur at any one of a number of places in the medication process. Medication errors can stem from prescribing, transcribing, dispensing, or

administration. These kinds of errors cause at least one death every day and injure more than a million people every year (Trakulsunti & Antony, 2018). Although this has been a known problem for many years, health care managers have not yet found a process or procedure to eliminate these kinds of errors. As Karavasiliadou and Athanasakis (2014) put it, the medication process begins with the physician's decision regarding which medication to use and how it needs to be administered and ends with the nurse giving the patient the medication.

Another study revealed a 48.8 percent error rate in 512 drug doses. Many were administration errors. Administration errors are things like managing the drugs, giving then on time (Haghbin Shahsavari and, Vazin, 2016). Monitoring was the most common type of error found in most studies.

Relevance to Nursing Practice

Miller, Haddad, and Kenneth (2016) report that nurses spend 40 percent of their time administering medications. Thus, nurses are critical and play a major role in reducing pediatric medication errors. However, there has been little empirical evidence that has been collected about the effectiveness of nursing education in reducing medication errors committed by nursing students. Traditional education focuses on the five rights of medication errors mentioned elsewhere (Miller, Haddad, & Kenneth, 2016). The five rights refer to right patient, right drug, right route, right dose and right time. One study found that the most common mistakes nurses made were wrong dose, wrong drug, and wrong administration route (Efstratios, 2017; Miller, Haddad, & Kenneth, 2016).

One study found 150 errors in prescribing medication (Glanzmann, et al., 2015;

Izadpanah, Kashani, & Sharif, 2015). That same study found that at least 70 percent of those errors caused harm. These kinds of errors cause at least one death every day. Further these errors injure more than a million people every year.

There have been numerous strategies and procedures implemented in an attempt to eliminate medication errors for all patients but especially for pediatric patients. Nurses reported that interruptions can interfere with their ability to administer medications. They also noted that illegible notes from the doctor and failure to check the patient's ID band with the record that identifies previous medications can cause them to make mistakes.

Nurses report they are more likely to make mistakes when they are short-staffed and when they are interrupted (Miller, Haddad, & Kenneth, 2016). Other causes include illegible written orders, incorrect dosage calculations, failure to check name band with the medication administration record, failure to follow policies and procedures, similar drug names and packages. These authors aver that there has been little progress with this problem in the last 15 years (Miller, Haddad, & Kenneth, 2016). They also argue that nurses are the last line of defense against these errors.

Maryniak (2016) reported a cross-sectional study that involved 203 nurses to examine medication knowledge and the risk of medical errors. Participants were from acute care hospitals and primary care settings. The study included a test on pharmacology, drug management, and drug calculations. Maryniak (2016) reported the findings of the study: participants had a 39 percent moderate risk and an 11 percent high risk for pharmacology knowledge, 33 percent moderate risk and 26 percent high risk with

drug management, and 32 percent moderate risk and 7 percent high risk with drug calculations.

These steps and actions will certainly help nurses to avoid making medication errors. Double-checking seems to be one of the most important steps to take because is provides support for the administration of any drug. Huynh et al. (2017) suggested that black box thinking be engaged to learn about and to prevent medication errors. One of their questions is: "What are the educational needs required to prevent medication errors?" (Huynh et al., 2017, p. 99). They are following along with the 'zero-tolerance' concept and policy regarding medication errors and suggest the black box thinking regime will help to eliminate these kinds of errors. In aviation, the black box is the forensic data that helps identify what went wrong. These authors also argue that medication error theory and human factors need to be included in nursing education, in fact, they argue for this to be included in the education of all healthcare professionals but especially for pediatric doctors, nurses, and pharmacists (Huynh et al., 2017).

Wright (2012) asserted that little is known about the organizational factors that are involved in medication errors. The nursing practice environment is an important factor in a nurse's administration of medication. A study by the Robert Wood Johnson Foundation looked at staffing levels, nurse's error interception practices, and rates of non-intercepted medication errors. There are lower rates of medication errors when nurses compare the medication administration record with the patient record at the beginning of each nurse's shift. Another important factor was asking physicians to rewrite orders when they could not be read (Wright, 2012).

In one study, a hospital engaged the pharmacist in the review of medication errors on the pediatric unit. They found that including a clinical pharmacist on the team resulted in fewer serious medication errors in the pediatric intensive care setting. The introduction of a barcode medication administration along with a preprinted order sheet led to a significant decrease in medication errors among adults but not as much with children (Maaskant et al., 2015).

Sitterding et al. (2014) focused on situation awareness or attentional dynamics. They said, "A gap exists in understanding attentional dynamics, such as nurse situation awareness while managing interruptions during medication administration" (p. 891). They report that experts have suggested the area that is least discussed and studied is attention and even more specifically, situation awareness. Interruptions during medication administration are frequent for nurses. They point out that it is important to understand the many factors that influence the experience of situation awareness for nurses. They also point out that the most reasonable as well as the most effective in terms of evaluating this situation is observational (Sitterding et al. 2014). In other words, the investigator watches what is happening. Other possible approaches include semi-structured interviews and even surveys.

The investigators reported that the major theme regarding the description of situation awareness during medication administration related to the nature of the situation awareness perception (Sitterding et al. 2014). Other themes had to do with interrupting the cognitive process. This includes understanding. The 'nature' referred to visual, auditory, and interrupting thoughts (Sitterding et al. 2014). Nurses in this study were

adept at differentiating noise and they had the cognitive reasoning to respond differently depending on the stimuli. They were also conscious of the needs of the team as well as the needs of the patients. What caused immediate interruption in the medication administration process was the phone (Sitterding et al. 2014).

Nurses were also able to determine the priority. For instance, if an interruption was more severe or more important, they were able to refocus, stop the medication administration, and attend to the more severe event (Sitterding et al. 2014). Following the completion of whatever needed to be done in the more severe event, they returned to the administration of medication. This example demonstrates how multitasked a nurse's duties are.

This study provided additional insight into the kinds of interruptions each nurse deals with daily and also how they are cognitively and emotionally able to deal with those. They are even able to prioritize, attend to the more important or severe and continue with the second priority issue.

Role of the DNP Student

Focusing on eliminating medication errors in the pediatric ICU had allowed me to learn a great deal about medication errors beginning with the numbers and percentages. The high percentages are discouraging since this topic has been discussed for more than a decade. Learning about the different strategies and interventions used to eliminate medication errors in the pediatric sector provided more insight regarding pediatric medication was enlightening. I was especially impressed with the articles about education. As a student, I am learning about how to avoid making medication errors.

However, I am fully aware that there are enormous interruptions in a nurse's work day. Nurses cannot simply shut everyone out when administering medication to a child (or any patient, for that matter).

As a leader of nurses, I will be responsible for supervising and monitoring. DNP Essentials II, identifies the ability to make, assess, and practice policies as a requirement (AACN, 2006) therefore, it will be up to set policies that will avoid pediatric medication errors. I will be able to use a great deal of the research done for this project. For example, one of the studies showed that more education about this issue during nursing training and continual training for nurses on staff can dramatically reduce the percent of errors made when administering medication to children.

I am a DNP student, and I am also a practitioner at this time. The information and data garnered during this project has opened my eyes more regarding this issue. Most of the medication errors are preventable. The adverse effects of medication errors are preventable. I strongly believe this and I know I will work towards this goal of eliminating all medication errors in the pediatric intensive care unit that is under my direction.

I have had strong motivation for all projects and all learning in the DNP program. I am excited to move on and upward in my career. I believe I can offer a great deal as a nurse leader because I have had positive feedback from participants in projects I have led. I know that it is critical that I continue to learn throughout my career. For one thing, things change. Different evidence-based practices and/or procedures become known. It is clear from the literature and from my work that evidence-based practices are a focus in

all healthcare institutions. Technology will also continue to change how we operate as healthcare professionals. My motivation for success and to contribute to health care at the highest level of quality has always been extremely high. I am eager to begin my work as a DNP.

Role of the Project Team

The Quality Assurance Manager will pull the adverse event reports data for this project and make sure that identifying patient information is deleted. The Pediatric Quality Team will be the recipients of this analysis and recommendations.

Summary

A comprehensive literature review did not reveal a procedure or a set of procedures that would definitely reduce and eliminate medication errors for all settings. Given the acknowledgement that all settings are different, a detailed analysis of the root causes, including human factors may provide insight into specific strategies which could be adopted in this PICU to reduce medication errors. Section three will describe the approach take in the design of the DNP project, as well as the practice-focused question. Section three will also present details on the sources of evidence and analysis of procedures used to address the practice-focused question, analysis, and the synthesis of the evidence.

Section 3: Collection and Analysis of Evidence

Introduction

Medication errors result in significant morbidity and mortality in U.S. hospitals. A decade ago, Hughes (2008) strongly argued that any mistake made must be interpreted as something wrong in the system. Hughes reported from the Institute of Medicine that "the majority of medical errors result from faulty systems and processes, not individuals" (p. 1). Thus, it is very important to adopt process improvement techniques that will identify the multiple involved in the care process and the possible causes of the error using a root cause analysis. It is an investigation and problem-solving approach that is focused on identifying and understanding the underlying causes of an event in addition to any potential events that were intercepted along the way (Hughes, 2008). It can be used to identify trends or to assess risks.

The practice problem is the high rate of medication errors in this hospital's PICU, where the population is particularly vulnerable due to their acute illnesses. The practice question is: "Will the analysis of specific data associated with medication errors and near misses pinpoint the key areas that should be addressed using evidence-based practice." The purpose of this capstone project was to perform a detailed analysis of the root causes of all cases of medication error in this hospital's PICU for the past 2 years. In the literature review, I identify types of errors and data regarding outcomes and that were used to categorize secondary data extracted from the hospital's quality assurance database. The summary of the root cause analysis and recommendations from the literature for improved clinical practice will be presented through the hospital's quality

assurance structure. The social change is the impact of improved practices on decreasing medication errors and improving health outcomes in the PICU population.

Sources of Evidence

The literature review supported the categorization of factors contributing to the medical errors. Among the databases that will be used to select articles are Pub Med, Ovid, EBSCO, Cochran, APA Psyc Net, and Oria (Pritham & White, 2016). Key phrases included *pediatric care, pediatric intensive care unit, medical errors in pediatric care, medical challenges faced by children in the intensive care unit, medical errors and mistakes faced by children in hospitals,* and *identification of medical arrears in PICU*. I performed a search from different databases, use different combinations of terms, and filter the articles obtained thoroughly to ensure that quality articles (see Cooper, 2015). Secondary data analysis was performed on information obtained by the director of quality assurance from the hospital medication errors reporting data base. The data was collected electronically via the hospital reporting data base (Midas). This data, which I uploaded for analysis, comes in several sections. The reporter contains the report that medication error occurred in the PICU along with the nurses' assessment and recommendations related to that medication error. Then, the administrative nurse manager (ANM) of the PICU has a section to be completed within 72 hours. In that section, he or she will discuss their findings after a thorough investigation and give their recommendation. Finally, the hospital quality department reviews the completed incident report and discusses their findings with the individuals involved, and the ANM will discuss the

incident with the rest of the nursing staff. This data will have no identifying information on the individual patient.

Analysis and Synthesis

The analysis looked at factors mentioned in the literature such as negligence, labeling errors, wrong dosage, and other actions that relate to medical errors. The identification of medical errors in the PICU was assessed based on the most likely cause of the error. For instance, while the administration of medication to a wrong patient may be due to wrong labeling and file mix-up, it may also be due to wrong diagnosis and disregard of patients' history. There is a complex process for any medication to get to the patient and each step of the process is examined in a root cause analysis. The process begins with the physician's decision to order a specific medication in a specific dose for a specific person, and a specific manner to administer the medication. The pharmacist receives the order and prepares and delivers the medication. The nurse reviews the order, prepares the medication, and then gives it to the patient. In many cases, this process is electronic. The review procedure is designed to capture the root cause of all medical mistakes in PICU.

Root cause analysis takes an event and back-traces it by charting causal factors at each step. This approach will also identify the causes for mistakes or events that happened in between time. The process includes identification (Hughes, 2008). For example, not double-checking prescriptions is an enabler because it provides one avenue where an error can be made. The researcher traces each incident backwards – what did the nurse do before giving the medication to the child, how was it delivered to the nurse,

how was it dispensed from the pharmacy or was it, how was it orders, who ordered it, how was the order made, etc.

The information was categorized by type of error. Categories could include: overdose, under dose, wrong dose, wrong medicine, wrong patient, wrong route, wrong time, and so forth. Errors will be placed under each category, which will give the researcher data regarding types of errors. The analysis procedure is one of identifying and categorizing types of errors as well as number of errors and the percentage of those that required intervention. Raw numbers will be translated into percentages, just as was done in all the studies cited. This was the method used in almost all research studies read. The need for more sophisticated statistics would come with the outcomes of implementing certain strategies.

The next step is the application of the human factor analysis, which highlights which errors, was a result of human error rather than system error. This information will help in developing recommendations for best practice.

Summary

Medication errors in the PICU have the potential for significant harm to vulnerable patients. A detailed review of the practices that contributed to a medication error may yield insights into how clinical practices can be improved to ensure the safety and positive health outcomes for acutely ill pediatric patients.

Section 4: Findings and Recommendations

Introduction

The PICU is a key target for quality improvement due to the complexity of care and the potential for medical errors in the setting. Medication errors lead to increased morbidity and mortality rates in children (Rinkel et al. 2014). The PICU at this medical center has experienced an increase in medication errors and near misses over the past 2 years according to the pediatric quality committee quality reports. This 26-bed acute unit offers care to a variety of children with different types of acute illness ranging from asthma, cardiac, liver, kidney transplant, neuro-surgery, and general surgery. Current quality practices in this pediatric unit have been ineffective in reducing the errors, thus creating the need to establish better and more efficient practice. Children, especially young, small, and sick children, are usually less able to physiologically tolerate a medication error due to their inability to communicate effectively to providers regarding any adverse effects that medication may cause (The Joint Commission, 2010).

The purpose of this quality improvement project was to examine the root cause for medication errors in the PICU and then recommend changes to interprofessional policies and procedures based on best evidence-based practice literature. The gap in current safe medication practice is demonstrated through the high number of medication errors and near-misses in this PICU over the last 2 years. The American Academy of Pediatrics (2018) argued that reducing pediatric medication errors is a collaborative effort.

Analysis and Synthesis

I performed data analysis on information obtained by the director of quality assurance from the hospital medication errors reporting data base (Midas). The report data contained the information on the reported medication error which occurred in the PICU along with the nurses' assessment and recommendations related to those medication errors. This retrospective study included data on errors in the PICU between September 2017 and December 2018. The purpose was to identify the number of errors, type of errors, and the severity of the errors with these critically ill children in the PICU.

The literature review supported the categorization of factors contributing to the medication errors. The analysis looked at factors mentioned in the literature such as negligence, labeling errors, wrong dosage, and other actions that relate to medication errors. The identification of medical errors in the PICU was assessed based on the most likely cause of the error. For instance, while the administration of medication to a wrong patient may be due to wrong labeling and file mix-up, it may also be due to wrong diagnosis and disregard of the patient's history. There is a complex process for any medication to get to the patient and each step of the process is examined in a root cause analysis. The process begins with the physician's decision to order a specific medication in a specific dose for a specific person, and a specific manner to administer the medication. The pharmacist receives the order and prepares and delivers the medication. The nurse reviews the order, prepares the medication, and then gives it to the patient. In many cases, this process is electronic. The review procedure was designed to capture the root cause of all medical mistakes in PICU.

Root cause analysis takes an event and back-traces it by charting causal factors at each step (Hughes, 2008). This approach will also identify the causes for mistakes or events that happened in between time. The process includes identification (Hughes, 2008). For example, not double-checking prescriptions is an enabler because it provides one avenue where an error can be made. The researcher traces each incident backwards – what did the nurse do before the medication was given to the child, how was it delivered to the nurse, how was it dispensed from the pharmacy or was it, how was it orders, who ordered it, how was the order made, etcetera.

The information was categorized by type of error. Categories included overdose, underdose, wrong dose, wrong medicine, wrong patient, wrong route, and wrong time. Errors were placed under each category, which gave me data regarding types of errors. The analysis procedure is one of identifying and categorizing types of errors as well as number of errors and the percentage of those that required intervention. Raw numbers were translated into percentages. This was the method used in almost all research studies read. The need for more sophisticated statistics would come with the outcomes of implementing certain strategies. The next step was the application of the human factor analysis, which highlights which errors were a result of human error rather than system error. This information was used in developing recommendations for best practice.

Findings and Implications

In 2016, the hospital rolled out their new hospital information system (EPIC) which was designed to decrease medication errors. This was not evident in the first year, but over a 2-year period there were improvements. Twelve months before the launching

of the hospital EPIC system there were a total of 51 medication errors in the PICU. One year after EPIC was launched that number went up to 64 medication errors, which may be attributed to the nursing staff, physicians, and pharmacist getting adjusted to the new system. Over the next 12 months there were only 26 medication errors reported as the nursing staff, physicians, and pharmacist were more familiar with the new system.

An analysis of 41 total medication errors discovered that 49% of the medication errors made in the PICU were due to the nurse administering the incorrect dose. This can be attributed to poor communication between the nurses themselves, nurses and physicians, and nurses and the pharmacy. Sixty percent of these errors occurred on the day shift when the unit is much busier and the patient's medication orders are constantly being changed. The second most occurrences were missed doses which accounted for 27% of the medication errors made in this PICU. These missed doses were mostly due to poor oversight or follow-up by the clinical staff, pharmacy, and the providers. There were instances where the physician and the pharmacy did not properly order and verify a medication, the nurse questioned the order but proceeded to administer the medication. There were other medication errors, some of which are reported in Table 1. The patient population was 16 males and 25 females.

Table 1

Breakdown of data by type of error, number of occurrences and nursing shift (N = 41)

Type of Error	Number of Occurrences	Percentages of Occurrences	Shift Day	Shift Night
Wrong dose	20	49%	12	8
Missed dose	11	27%	7	4
Wrong time	3	7%	3	0
Wrong drug	4	10%	2	2
Wrong route	2	5%	2	0
Wrong patient	1	2%	0	1
Total	41	100%	26	15

Sixty three percent of the medication errors reported occurred on the day shift, compared to 37% on the night shift. The difference may be attributed to the patients going for testing, procedures, and other departments when various professionals are making changes in the patient's chart and documenting new orders which were not be picked up in real time by the primary nurse. In comparison, on the night shift most other departments are gone for the day and fewer changes are done in the patient's chart, which is evident by an almost 60% difference in medication errors occurrences. Fortunately, staffing was not an issue as the unit was adequately staff over 90% of the time.

On this PICU unit, 27% of all the medication errors resulted in harm ranging from diarrhea to prolonged intubation, and none of the harms from these errors resulted in injuries nor a prolonged hospitalization stay. The wrong dose is often attached to the wrong calculation of the age, height, and weight of the child because many of the pediatric medications are determined by the age, height, and weight of the child. Haghbin et al. (2016) reported that medical errors typically occur at one of four stages: prescription, administration, transcription, and dispensing. How severe an error is can be classified into seven levels ranging from Level 0, which is potential error without harm to Level 6, which is fatal complication as a result of the error (Haghbin et al. 2016). Table 2 presents these errors.

Table 2

Level of Harm

Harm Score	0	1	2	3	4	5	6	7
Number	30	2	4	2	1	2	0	0
Percentage	73%	5%	10%	5%	2.5%	5%	0%	0%

The most common drugs involved in these medication errors range from respiratory medications such as oxygen and nebulizer treatments, blood pressure medications, electrolyte replacements, and narcotics and antianxiety medications.

Table 3

Types of Drugs Administered in Error

Type of Drugs	Number of Errors	Percentage
Respiratory	8	20%
Electrolytes	7	17%
Blood Pressure	6	15%
Narcotics	5	12%
Antianxiety	5	12%
Anticoagulant	3	7.5%
Anticonvulsant	2	5%
Antibiotics	1	2.5%
Immunosuppressant	1	2.5%
Smooth Muscle Relaxant	1	2.5%
Antidiarrheal	1	2.5%
Anemia	1	2.5%

The analysis was intended to understand the specificity and contributing factors for medication errors in this pediatric ICU. Based on the medication error reporting system there were a number of errors than could have been prevented. Errors were caused due to poor communication, interruptions, incorrect dosage calculations, and medications not delivered on time. Surprisingly staffing, failure to properly identify their patients, look alike and sound alike drugs were not high on the list of reasons for medication errors in this PICU.

Recommendations

The American Academy of Pediatrics (2018) argued that reducing pediatric medication errors cannot be accomplished by one person or even a small group of professionals. It requires a broad collaborative effort with professionals from different medical and health care sectors. As has been pointed out, pediatric patients are at high risk for these kinds of errors. They cannot express themselves as adults who can say exactly what they are feeling. One of the errors found is the wrong dose or the wrong route in terms of dispensing medications to children. The wrong dose is very often a miscalculation because the appropriate dose of so many medications is based on the age, height, and weight of the child. It is easy to make a mistake in these calculations or to read the chart wrong. When doctors give oral instructions for certain medications, what he or she says can get lost in the typical noise in the hospital.

This analysis suggested that there is a need for more than one intervention to reduce medication errors in the PICU. Leadership should focus on supporting good medication safety practices that include no blame culture, promote learning

from errors, and involve new technologies. Also, it is equally important to put in place suitable monitoring methods over long periods of time to assess the suitability of interventions. The review also identified a key gap in literature and that there are limited interventions available in the PICU, even though the PICU is a high-risk area that provides round the clock medicine administration.

Manias, Kinney, and Cranswick (2014) conducted a meta-analysis to find the interventions that worked to reduce medication errors in pediatric intensive care units. They reviewed 34 articles on the topic. Based upon their review, they recommended computerized physician order entry, education of staff, pharmacist involvement, protocols, and support systems for decision making were helpful in reducing the number of medication errors in the pediatric ICU (Manias, Kinney, &, Cranswick, 2014). Technology has been adopted in health care because much of it works to improve quality and safety for patients. Electronic prescribing is one of those electronic tools. This is a process that improves clinical decision-making, facilitates hand-offs, and improves medication adherence (Johnson, Lehmann, & Council on Clinical Information Technology, 2013).

In 2008, the Centers for Medicare and Medicaid Services identified e-prescribing as a style that allows prescribers to generate and send prescription orders more clearly. It is sent directly to the pharmacy that will dispense the medication. It is nearly error-free (Johnson, Lehmann, & Council on Clinical Information Technology, 2013). There is no problem understanding the physician's hand-writing, for instance. Studies have shown

that e-prescribing "can improve prescribing quality and provide better pharmacovigilance (Johnson, Lehmann, & Council on Clinical Information Technology, 2013).

This facility has upgraded their electronic medical records (EMR) as a step to eliminate medication errors. The computerized order entry system should help to improve the safety of the PICU medication orders; it is an error preventing tool that guides the provider on the preferred drug doses, route, allergies, and frequency of administration. Another benefit of the computerized medication order is that it has a hard-stop as a measure of forcing function and error prevention.

Pharmacists know the latest information about drugs, how they are used, and problems situations (Benjamin, 2018). Pharmacists have said that the net effect of e-prescribing is positive in terms of patient safety, efficiency, and effectiveness of care. E-prescribing improves communication between different professionals and lay people (Johnson, Lehmann, & Council on Clinical Information Technology, 2013). E-prescribing is one of the recommendations for the hospital that is conducting comprehensive research on how to eliminate medication errors in the pediatric intensive care unit.

The person who actually gives the medication to the patient is typically the nurse. Nurses have acknowledged that interruptions in their work can interfere with their ability to administer the right medication at the right time to the right person. Accommodations should be made for the nurse to give their medications without any interruptions. Most often the nurses administering the medications are interrupted by other staff members from other departments, family members and patients.

There is a need to adopt policies and procedures that all staff, including nurses, can perform that will decrease the number of errors. Needing slightly different procedures for the medication team and nurses is not uncommon. Utilizing regular data analysis, the team can then modify their changes to better fit the needs of the unit. Further, the procedure or policy must fit the specific types of errors being made in this PICU. There would be different tactics for the error of overdosing and the error of ordering the wrong drug. Virtue Health conducted a Six Sigma process and was able to identify things that were wrong. They set up a new patient chart review procedure and worked to correct the errors. They used Six Sigma to improve delivery of medication in the heart section showing that Six Sigma has a great deal of promise to make a positive difference in hospitals in terms of reducing medication errors (Bisk, 2018). It began by identifying and defining medication errors using a multidisciplinary team. They thoroughly examined each step in the process, including physician order, order review, pharmacist order entry, dose preparation, and dose dispensing (Buck, 2017). From there, they were able to identify some of the causes and some of the mistakes to change to have fewer medication errors.

Trakulsunti and Antony (2018) drew similar conclusions in their study with Six Sigma and Lean. They presented case examples to demonstrate how medication errors were reduced with the use of these two applications. Applying Lean in the health care sector has resulted in reductions in operational costs, improving speed of actions, improvement in patient care and patient safety and staff. Lean is particularly favored by health care managers because it combines cost reductions with increases in patient safety

and increasing standards of health for patients (Trakulsunti & Antony, 2018). As an example, a mid-sized hospital initiated a Lean Six Sigma project to reduce medication errors. The team implemented DMAIC, Define-Measure-Analyze-Improve-Control methodology during the define stage; the team used a project charter that identified the scope and goal for the project (Trakulsunti & Antony, 2018). The scope was focused on the medication order process with the intention of reducing administration errors. The team reviewed errors that were observed in the pharmacy medication order. They used brainstorming to find the root causes of all types of errors and to recommend solutions that would reduce these errors. One recommendation was to use computerized physician order management systems. The error rate was decreased from 0.33 to 014 in just five months. There was a labor cost reduction of $550,000 per year. There was a high increase in patient satisfaction and employee morale was enhanced (Trakulsunti & Antony, 2018).

Hospitals need to have accepted pediatric standards in terms of dosing and limits in emergency and PICU, including having a standard pediatric formulary with specific standard dosing. The medical staff would benefit from seamless education and training as well as practice patterns for prescribing the high-risk medications (American Academy of Pediatrics, 2018). The following ideas for standards in providing medication to pediatric patients have been tested in various settings. Some of the recommendations include the adoption of computer physician ordering, developing a standardized formulary that will provide ongoing training and education in drugs, and be sure that all prescriptions are okayed by pharmacists. Pharmacists know the latest information about drugs, how they are used, and problems situations (Benjamin, 2018). Training is critical in all

medications, but children are at higher risk than adults. These steps can close the gap between theory and practice. It will close the gap between patient safety and patient risk.

Medication errors in pediatric ICUs are not something that can be left or ignored; steps must be taken to eliminate these harmful errors. The PICU treats children in critical conditions, and any service rendered to them must be of utmost accuracy to avoid further complications. The administration of drugs to the pediatric patient may affect his/her tissues leading to differences in the absorption effects (Ferner, 2009). Pediatric patients can experience muscle wasting and must be handled with a lot of care to prevent further complications. Thus, monitoring the conditions of the patients like the core temperatures of the patients and their states contributes to the risk of excessive drug release and usage.

Based on this study the root cause of these errors seemed that there was insufficient communication between the nursing staff, the nursing staff and the providers, and the clinical staff and the pharmacy. Majority of the errors occurred during the day when most of the patients are going for tests, seen by other services, and orders are constantly changing. The following standards and other actions that would reduce medication errors in the pediatric intensive care unit: (1) all new orders are verified by two register nurses, (2) pharmacist confirming all medications delivered to the PICU with the primary registered nurse, (3) all other departments on the unit such as respiratory, perfusionist, conduct a shift report and be part of the shift huddle, and (4) creation of a professional hand-off report tool for nurses to use for patients transferring in and out of the PICU.

Strengths and Limitations of the Project

The success of this project was directly related to the cooperation of the team that assisted me in pulling together the information. Another strength is that the sample size, which was over 40 errors over 16 months and 1,453 patient days. Retrospective patient record review is currently still seen by many as the gold standard for obtaining information on the incidence of preventable medication errors for the whole hospital population (Baines et al 2012). This study has made it possible to keep an eye on patient safety in the PICU. Based on this evidence, that medication errors are a significant percentage of medical errors in children. This review estimated that 3-48% of medication orders for children will lead to an error somewhere along the spectrum of the entire delivery process from prescribing to administering.

The limitation of the research is the unavailability of the patients' records including the nurses' progress notes to extract data. This study came from a single study unit in a hospital therefore the incidence of errors was an estimate and was not based on the number of admissions to the PICU over the study period but on the number of medication errors reported. Finally, incident reporting is highly dependent on institutional and unit cultures.

Section 5: Dissemination Plan

Dissemination Plan

Medication errors happen too often in hospitals, and they can be especially dangerous in the PICU. The primary focus of this study was to better understand the causes of medication errors in order to reduce pediatric medication errors. The guiding practice question was what is the scope and root causes of medication errors in this PICU?

The review and analysis showed that of 41 total medication errors made in the PICU, 49% of the medication errors were due to the nurse administering the incorrect dose. This can be attributed to poor communication between the nurses themselves, nurses and physicians, and nurses and the pharmacy. Sixty percent of these errors occurred on the day shift when the unit is much busier and the patient's medication orders are constantly being changed. The second most occurrences were missed doses which accounted for 27% of the medication errors made in this PICU. These missed doses were mostly due to poor oversight or follow-up by the clinical staff, pharmacy, and the providers. There were instances where the physician and the pharmacy did not properly order and verify a medication, the nurse questioned the order but proceeded to administer the medication.

This analysis suggested that there is a need for more than one intervention to reduce medication errors in the PICU. Leadership should focus on supporting good medication safety practices that include no blame culture, promote learning from errors, and involve new technologies. Also, it is equally important to put in

place suitable monitoring methods over long periods of time to assess the suitability of interventions. The review also identified a key gap in literature and that there are limited interventions available in the PICU, even though the PICU is a high-risk area that provides round the clock medicine administration.

Dissemination

The goal for this dissemination plan is to inform the quality committee, leadership and the nursing staff, physicians, respiratory therapists, and pharmacist about the results and to present evidence-based strategies and processes that have been successful in reducing PICU medication errors. The PICU team and I can make a poster that would focus on reducing errors in the PICU. All kinds of print formats would be appropriate for disseminating the program and results. The desired result is that the pediatric leadership champion a program to prevent medication errors that include the evidence-based strategies. This program would be evaluated and then, if successful, have the results published to a wider audience in the pediatric field through posters, presentations, and publications. The primary audience is healthcare professionals. This includes physicians, nurses, and pharmacists. The second audience would include all other stakeholders, like the board for the hospital.

Analysis of Self

Like many people in this program, I am a practitioner, so I am taking care of patients and fulfilling numerous other duties while I study to become more knowledgeable and more skilled. In fact, the continuing access to new knowledge has helped me in my job even now. This is exciting to me because I am passionate about

becoming an excellent nurse leader. This is being achieved through study and practice in the program in which I take the role of scholar. Just as the program provides more knowledge for my practice, my practice helps me learn more quickly. The opportunity to act as a project manager has provided invaluable experience for the time when I finish the program.

All of this helps me work towards my professional goal of being a senior nursing leader and policy developer. I chose to be a nursing leader because there is a need for more nursing leaders. I think my skills in communication would be useful in this kind of position. However, now it is very important to me to drastically reduce the number of medication errors in the PICU in this hospital. Research clearly shows that most of the errors are preventable. In the immediate future, I am going to work very hard to achieve this goal.

Description Project Completion

I knew there were medication errors, but I did not know there were so many in this PICU. It is critical that these children receive the right medicine. I have had strong motivation with all projects in my courses. I believe in approaching things positively and looking for the things I can learn. It has been exciting to be a scholar.

Summary

The problem for this project is how to eliminate medication errors in the PICU. A great deal of research was read and studied. One thing that is clear is that the same strategies to achieve the goal would not be the same for all hospitals. This is because the population differs from region to region. There are, however, specific strategies that

could be used successfully every place, and one of those are training and educating nurses about the incidence of this problem and how they need to look at drugs that come into their hands. Another thing is to make sure the physicians are clear and comfortable about the medication they order on the computer.

This paper discusses some of the many strategies that have been successful in different places. It also includes process/program for use in this hospital. The successes at this hospital can be duplicated in other places even if they need to be adapted.

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