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# Evaluation of the Medication Use System in a Community Teaching Hospital

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# ABSTRACT

Patient safety in hospitals is a primary focus in today's health care environment. One way to improve the overall safety of patients is by developing a safe medication use system. The medication use system is a complex process that involves many steps and health care individuals. Due to the complexity of the process and broad range of medications used in hospitalized patients, there are many possible ways in which medication errors can occur.

An extensive literature search was conducted to identify technologies and strategies for minimizing medication errors in key parts of the medication use process. These best practices were compared to the current medication use system at St Alexius Medical Center.

This extensive analysis has provided the groundwork for performance improvement initiatives that should be pursued in improving the medication use process in the hospital in the next several years. Several minor areas of improvement have been identified. These include ensuring routine medication orders are reviewed by a pharmacist before the medication is administrated, preparation of intravenous admixtures for the Neonatal Intensive Care Unit and the Emergency Room by the inpatient pharmacy. The major areas to focus improvement strategies are intravenous medication pumps, full implementation of a bedside point-of-care bar coding system for medication administration, decision support systems while performing prescriber order entry, and physician preprinted orders.

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The medication use system in a health care environment is a complex process. The components of the system include the following subprocesses: medication prescribing, medication order processing, medication preparation, medication procurement, medication dispensing, medication administration, and monitoring of medication effects on the patient (Cohen, 1999). Each subprocess has complexities of its own and needs to be structured for the most positive outcome.

This study will include an extensive review of the literature around the medication use process looking for theories and technologies for making the medication use system safer in each of the subprocesses. After this information is collected, these theories and technologies will be compared to the processes and technologies in place at St Alexius Medical Center. As the Director of Pharmacy, I have an influential role in developing the process improvement plans for the medication use system. This study will provide the framework for implementing the most valuable patient safety process improvement strategies for the next several years.

St Alexius Medical Center is a tertiary care center that serves patients from Central and Western North Dakota, Eastern Montana, and Northern South Dakota. St Alexius is a mid size hospital that is staffed for approximately 205 inpatients. The medical center also provides extensive hospital outpatient and clinic services. For the scope of this study, the main focus on the medication use process will be in the area of inpatient and outpatient hospital services. These areas compromise twenty-five major areas within the medical center. The medical center has approximately 10,000 discharges per year and provides services to a large number of outpatients

annually. There are approximately 600 nurses employed by the medical center and over two hundred physicians have privileges to practice there. The inpatient pharmacy is staffed 24 hours per day all year long. The inpatient pharmacy dispenses approximately 1.5 million doses, processes approximately 450,000 medication orders, and receives about 150,000 order sheets annually. Nursing staff administer approximately 1.2 million doses each year.

Even if our medication use system was 99.9 percent accurate, there would be 1,500 dispensing errors, 450 medication orders processed incorrectly, and 1,200 medication doses given incorrectly each year. In health care, these errors can lead to significant patient harm or even death. Concern about medication safety in hospitals in not a new issue. Medication errors started to receive attention during the 1950's. Barker et al (1968) identified one out of every six doses was in error in a study involving 572 doses of medications administered by nine nurses in a Florida hospital in 1959. In today's environment, the medication use system is much more complex than it was 50 years ago. The number of pharmaceutical agents available is growing at a staggering rate. Between 1990 and 2000 there was a 500% increase in the number of medications made available through the FDA approval process (ISMP, Call to Action 2000). Patient turnover in hospitals is much faster than in years past. Historically it was common for a patient to stay a week in the hospital after the birth of a baby. In today's environment, the patient who has a normal delivery will stay approximately forty-eight hours in the hospital.

In 1999, the Institute of Medicine published a landmark report about safety in health care. The Institute of Medicine report, To Err Is Human: Building a Safer Health System, illustrated that between 44,000 and 98,000 deaths occur each year in the United States due to medical errors. Medication errors in and outside the hospital are estimated to cause approximately 7,000

deaths annually (Phillips et al, 1998). These reports ignited public policy discussions and increased the focus on patient safety by many patient safety and accreditation bodies.

Even though pharmacists and pharmacist leaders understand the importance of developing safe medication use systems, it is difficult to identify where to focus process improvement initiatives. The basic question of how do I begin to make the medication use system in the hospital safer is very challenging due to the magnitude and complexity of the medication use system (Manasse and Kasey, 2005). This study is being conducted to assist me in my role as Director of Pharmacy Services with answering this basic question.

A thorough review of the literature around patient safety and medication use systems was conducted by searching PubMed, MedLine, Iowa Drug Information System, and the internet. These searches provided a large volume of references around the subject matter as well as evidence of a major focus on this topic by several national organizations. Information from national organizations like the Institute of Safe Medication Practices and the American Society of Health-System Pharmacists was collected to continue to build on the subject matter. Key pieces of the literature from all these sources were collected and reviewed. This review helped refine the search to important literature that substantiated some of the more global references identified in regard to the medication use system. Further literature was also collected by reviewing the works cited pages for pertinent literature to the topic.

## GENERAL THEORETICAL CONCEPTS

### CULTURE

Three important concepts emerged during the review process that need to be described before proceeding into the analysis of the subprocesses of the medication use system. The first

concept that emerged revolves around the importance of a culture of safety. Developing a safe system is complex. The health care process has grown significantly from the time a physician could carry their entire armamentarium in a black bag (Giorgianni et al, 2000). Along with the growth of technology, procedures, and medications came the growth of a culture of secrecy and punitive reactions surrounding errors that occurred in health care. This type of approach did not create a culture in health care making patient safety a priority. Health care organizations are now challenged by changing the culture to one with a high focus on patient safety. Health care has not transformed its culture quickly. A culture of safety needs to be non-punitive or blameless in nature. It requires an understanding that the errors are caused by the system and not the person working within the system. Constant reporting of near misses and errors is vital so these situations can be thoroughly analyzed for system problems. Ongoing efforts of process improvements focusing on improved safety should be a common theme in an organization. Incorporating the patients into the safety process is an important part of the system. Patients should be informed that they are needed to play an active part in the safety of their health care. Coupling these principles with an unwavering support for patient safety by the leadership of the organization will transform culture over time (Manesse and Thompson, 2005).

Several years ago, the hospital formulated and adopted a policy for errors that is non-punitive and systems based. Even though the process is to review the system for causative factors, staff members may be held accountable for mistakes made when they negligently bypass safety components of the system (Institute of Medicine, 2000). An example of this would occur if a nurse administers the wrong medication to the patient. If the nurse did not use the bar code scanning device in place to prevent this type of error because they did not feel it was necessary,

the nurse could be held accountable for their actions. In the event the safety system was bypassed because the computer was not working at the time of medication administration, the system would be blamed for the error instead of the nurse. These unique scenarios can be an area of confusion for management and staff members. Management staff working toward creating a culture of safety may not hold staff members accountable for bypassing critical safety steps in the system in efforts to create a non-punitive environment. Staff members may see disciplinary action taken against colleagues for errors made and not understand the reasons behind the actions.

The hospital has had a program in place for reporting near misses and errors for many years. These reports are generated by staff based upon criteria established in policy. The report is then reviewed and investigated by the supervisory staff for system failures and possible performance improvement. It is essential to analyze the errors thoroughly to identify the latent failures in the system which have lead up to the error. Discovering and fixing latent failures in the system are likely to have a greater effect on building safer systems than efforts to minimize active errors at the point in which they occur (Institute of Medicine, 2000). In the example of the bar coding technology being bypassed because of the computer not working, the simple solution would be to fix the computer. Some possible latent failures are that the information system infrastructure is not set up to quickly fix a computer problem or that there is not another computer available to use in the event the primary computer is not functioning. Unless these latent failures are not resolved, the potential of a nurse administering a medication in a room without a functioning computer will occur again is very high.

In the past year, the hospital's patient safety committee developed a patient safety

brochure to be given to patients that are admitted to the hospital. The brochure illustrates the organization's commitment to safety and provides patients with guidance on how they can play an active role in preventing errors. A patient opinion survey was also developed to study how safe patients felt while they were in the hospital.

HUMAN FACTORS

The second concept evolves around the human condition. An example of our human condition can be illustrated by a commute home from work that you are not able to remember. Another example is planning to run an errand on the way to work but arrive at work without running that errand. The human mind has the ability to perform routine or familiar tasks unconsciously. The human mind also has the tendency to forget or to make mistakes when we try to alter familiar behaviors or patterns (Barker et al, 1999).

There are many characteristics of the human condition that may impact performance. Some of the items that may affect performance are education, training, sleep deprivation, light levels, interruptions, noise level, team dynamics, team communication, dependence on short and long term memory, and workload (Manasse and Thompson, 2005). All of these need to be considered when developing systems in health care.

The study of human factors is just beginning in health care. Human factors is defined as the study of the interrelationships between humans, the tools they use and the environment in which the live and work (Weinger et al, 1998). In health care, people not only interface with equipment but also with multiple other health care professionals who are engaging in rather extensive, critical, and often times non-routine situations themselves (Grasha, 2000). Focusing on simplifying and standardizing processes, building redundant checks into a system, improving

communications and coordination within teams are examples of ways to improve the safety of systems by taking into consideration human factors (Institute of Medicine, 2000). Unfortunately there has not been much broad application to building in human factor principles into improving the safety of the medication use system because of the high variability in the processes and people involved, perceived up-front costs, and multiple conditions in which drug therapy is prescribed, dispensed, administered, and monitored (Schneider, 2002). Utilization of bar code technology before a patient receives the medication is one broad example of how human factors can be improved in the medication use process. However the implementation of this process that helps ensure the right patient receives the right medication via the right route at the right time is costly and cumbersome.

The hospital established a patient safety committee in 2001. The committee meets on a monthly basis and is responsible for overseeing and initiating patient safety initiatives. The committee is comprised of senior leadership and managers from nursing, pharmacy, and risk management. Safety does not reside in a person, device, or department but it comes from the interactions of components of a system (Institute of Medicine, 2000) This group has not received any formalized training on human factor principles or on safety strategies. There has not been any formalized training of supervisors or staff on these concepts either. Ongoing training of leaders and staff may be beneficial for developing a safer medication use system.

LITERATURE

The third concept pertains to the type of literature available describing best practices and and recommendations for improving medication safety. Since the medication use system is complex and the focus on safety is in its developing stages, many of the recommendations for

improving medication safety are based upon experience, logic, common sense, and human factor based applications from other fields. Even though there is not a great depth of research in this area supported by controlled trials, the recommendations will provide positive results in the area of patient safety. The lack of scientific evidence for common safety practices usually reflects the inherently obvious value of the process as determined by non-controlled trials or non-medical applications. In areas of health care where there is sufficient evidence of improvements in safety and positive outcomes, there has been an increased push to make these improvements across the country in health care organizations (Manasse and Thompson, 2005). One example is that of the review of quality data by the Centers of Medicare and Medicaid(CMS). Effective October 1, 2005, CMS is reviewing health care organization data in regard to certain indicators of quality care and are determining reimbursement rates based upon how good the quality of care is that the organization provides to the recipients of Medicare benefits.

Self Assessment Guide

How to analyze the medication use system for opportunities for improvement has been already identified as a significant challenge. The Joint Commission expects ongoing evaluation of the hospital's medication use system by evaluating the system for risk points and developing process improvement strategies to improve safety. The Joint Commission also expects the hospital to evaluate the literature for new technologies and successful practices from other organizations that may benefit patient safety (JCAHO, Standards 2005) The American Society of Health-System Pharmacists has produced a self assessment guide for evaluating the medication use process in a health care organization (ASHP, Self Assessment 2004). Another self assessment tool from the Institute of Safe Medication Practices is also available (ISMP, Self

Assessment 2004). These tools are a starting point in the review process of the medication use system in a health care organization. Neither of the tools provide a ranking for what areas should have the greatest impact on patient safety if implemented first. Also both tools do not provide any background information on the criteria the tool is evaluating. This requires further investigation into how to prioritize process improvement activities. The ISMP tool is much more thorough than the ASHP tool and will provide more specific information on where improvements are needed. The ISMP tool also has criteria included that are not widely practiced but felt by ISMP to be beneficial to the safety of the health care systems. These criteria have been added to evaluate how hospitals utilize these strategies over time. It can be confusing when this type of criteria is not differentiated from other standard of care criteria that may be felt to be of greater importance at this time. The ASHP tool also has value but is more general in the assessment questions and has even less background information than the ISMP tool. This generality may create a greater sense of ambiguity in what should be done to meet best practice guidelines.

These general theoretical concepts need to be incorporated into the review of every other subprocess of the medication use system. If the process improvement activity does not consider the culture or human factors in the design, the process improvement may fall significantly short of the target. A review of the literature is important as well when working on a process improvement. This review may provide key information to help make the process improvement successful. All of these concepts need to be kept in mind as the medication use system is reviewed.

## PRESCRIBING SYSTEM

The first major area of the medication use system to be analyzed is the area around the

prescribing function of medication orders. Some of the key components of the prescribing system include formulary management, verbal orders, handwritten orders, preprinted orders, available information, dangerous abbreviations, and computerized prescriber order entry systems(CPOE).

## FORMULARY SYSTEM

The formulary is the list of medications that has been approved by medical staff for use in the medical center. Before medications are allowed to be used in the medical center, the medications should be reviewed by a medical staff committee. This review should include analysis of the safety and efficacy of the agent, special handling and administration requirements, any problem prone aspects of the medication in regard to medication safety, and cost of the medication (ASHP, Formulary System 1992). The medical center has a formalized process for this evaluation to occur at a monthly meeting of the Pharmacy and Therapeutics Committee. The only challenge that is currently encountered is the limitation of resources available to complete all of the reviews thoroughly in a timely manner.

## VERBAL ORDERS

Verbal orders are often misunderstood or misinterpreted and are a major source of medication error (Rich, 2002). The JCAHO requires special processes be in place when verbal orders are taken. This process includes minimizing the use of verbal orders whenever possible. In the event a verbal order is necessary, the recipient of the order is to write the order and then read back the order to ensure the information was collected appropriately (JCAHO, Patient Safety 2004). The medical center has a policy in place to meet this requirement. There is also an ongoing chart review to ensure the practice of the employees is meeting the established threshold for this requirement.

## HANDWRITTEN ORDERS

Handwritten orders can be a significant source of error due to legibility issues and lack of standardization. Any time there is any ambiguity in a handwritten order, the prescriber should be contacted for clarification (ASHP, Preventing Medication Errors in Hospitals 1993) . Even though current hospital policy supports this practice, health care workers will seek out assistance from other members of the health care team to help interpret ambiguous orders. This is common in health care (Cohen, 1999). The culture has been to minimize contacting the physician. The aversion may be due to intimidating behavior of the physician or the desire to not bother this important individual with a simple question. We have to work towards increasing the direct contact to the physician whenever there is a question about the order that cannot be clearly answered by the nurse and pharmacist (Cohen, 1999).

As needed medication orders should include information for what indication to use the medication (National Coordinating Council, Prescription Writing 1997). The information provides clear information to the nursing staff on how to use the medication. The preprinted order sets have this information, but handwritten orders may or may not include the indication. The current hospital policy does not require an indication for handwritten as needed orders. This policy needs to be revised to include this expectation and then orders without that information need to be clarified when they are written.

## PREPRINTED ORDERS

Preprinted orders should be utilized as much as possible to increase legibility, standardization, and provide consistency in order information (ASHP, Preventing Medication Errors in Hospitals 1993). The hospital currently utilizes a significant number of preprinted

physician orders. Unfortunately, the process for these orders has not been overseen very well over the past decade. The hospital has had three different physicians fill the chief of staff position in the past ten years. During the transitions from one chief of staff to another, there have been significant lengths of time where the hospital operated without this liaison between the hospital administration and the medical staff. This fragmentation in the physician leadership has allowed for multiple problems with preprinted physician order forms to develop. Over time, several different order templates evolved. One template gave the directions only to activate orders that were circled. Another template required all orders to be activated unless a line was drawn through the order on the order form. Having these types of orders in the system has caused ambiguity for hospital staff. Physicians have also incorporated many duplicate orders on these forms which do not give clear direction to nursing on how to implement some of these medication orders. For example, the order form may include six different medications for pain control. Of the six medications, three will be injectable pain medications and the other three will be for oral administration. The orders do not clearly indicate how the nursing staff is to proceed in utilization of these medications. Some physicians have bypassed the hospital process for preprinted orders and bring in their own format from their own clinics. This lack of standardization increases the chance of errors to occur. Standardization of procedures, displays, and layouts reduces errors by reinforcing pattern recognition (Cohen, 1999)

The medical center is restructuring the template and process for standing orders under the direction of a physician champion in this area at this time. A physician champion is a physician who believes in and supports a process. This physician also will work to influence and convince other physicians to buy into the new process and adhere to the new process.

The relationship between hospitals and physicians is complex. Kleinke (1998) points out that "nothing less than a long, complex, uneasy history, characterized by stormy coexistence, stands between hospitals and physicians" (218). The reason is that both the hospitals and physicians depend upon each other but historically were not financially aligned together. In the past, all hospitals needed physicians to keep their beds occupied and physicians needed the hospitals to provide complex services to their patients. The power balance between the two has tilted in favor of the physicians. The physicians' informal power is a complicating factor in which hospital management has to consider in many aspects of daily operations. Physicians influence or intimidate the front line staff. This behavior will often cause staff to do as the physician says and not what they are being asked to do by the hospital management. In today's health care environment, many hospitals and the majority of physicians practicing there are aligned financially by the physician being employed by the health care system. This can improve the relationship between physicians and hospitals but does not solve all of the problems. St Alexius is the only major hospital in the state that does not employ the majority of physicians who practice at the medical center. This continued disunion of financial interests causes ongoing difficulties in managing physician behavior and implementing patient safety strategies at the hospital.

INFORMATION AVAILABILITY

Having the necessary information available at the time needed for prescribing is a vital component of the medication use process (Manasse and Thompson, 2005). The hospital has drug information in both electronic and written format available on all patient care units. In addition to general drug information, patient specific information is necessary at the time of prescribing. The

Joint Commission (2005) Standard MM.1.10 states that at minimum the following patient specific information is available: age, sex, current medications, diagnosis and comorbidities, laboratory values, allergies and past sensitivities. When it affects treatment, the hospital also has to have available to those involved with the medication management the patient's height and weight, pregnancy and lactation status, and any other information necessary for safe medication management. The pertinent laboratory, radiology, history and physical information are readily available through electronic formats at the computers in each patient care area and in the pharmacy. The hospital currently does not have a consistent process for providing pregnancy and lactation status of patients to the pharmacists. This is important because some medications should not be administered to pregnant patients due to the potential harm to the unborn baby. A similar situation may arise with patients nursing babies. Some medications pass into the breast milk and can cause harm to the nursing infants.

ABBREVIATIONS

Certain medication abbreviations have been attributed to significant medication errors and should not be used in the medical center (Lesar, 2002). One example of a dangerous abbreviation that has been used historically in health care is the letter u for the word unit. When only the letter u is handwritten instead of writing out the entire word unit, it can be confused as a 0 (zero). This confusion could lead to a ten fold overdose of a medication. The most common medication prescribed in units is insulin. Insulin is a medication used for diabetic patients to control their blood sugar. Insulin is also one of the more dangerous medications used because it has a narrow therapeutic window. A narrow therapeutic window means that a small change in dose of the medication can cause a significant effect on a patient. If an order is written for the

patient to receive 4 u of insulin and due to legibility or conformational bias the order is interpreted as 40 units, the patient could receive a ten fold overdose of a medication. This could lead to potentially life threatening low blood sugar in the patient. A policy prohibiting certain error-prone abbreviations exists at the medical center. The prohibited dangerous abbreviations are listed on the top of the physician order form as an ongoing reminder and reference. Chart review is conducted on a monthly basis with communication directly back to the employee or prescriber if a dangerous abbreviation has been used in the chart.

## COMPUTERIZED PRESCRIBER ORDER ENTRY

The one process that could systematically improve many of the prescribing issues is computerized prescriber order entry (CPOE). The benefits of CPOE have been a discussion point for over 30 years (Sittig and Stead, 1994). The potential of improving the medication use system is dramatic. CPOE will automatically remove any issues of legibility. Preprinted and standardized order sets are built into the system and initiated by the physician. The mechanism in which this would be accomplished eliminates the variability from one physician to another and would decrease ambiguity in the ordering process. The system could be programmed to provide hard stops so physicians would be required to provide indications for the as needed medications they prescribe. The program would eliminate the use of dangerous abbreviations as well. In addition to all these process improvement components, CPOE's greatest impact would be seen by providing clinical decision support information at the time of prescribing. For example, most medical patients over the age of 50 should receive some form of therapy to prevent a blood clot from forming in their legs when they are hospitalized. The CPOE system could automatically prompt the question of which therapy type the physician would feel is best for the current patient

versus the current system of reliance on memory for making this evaluation. CPOE can also be structured to provide physicians with information to make cost conscious decisions at the time of order generation (Sittig and Stead, 1994)

As a pharmacist, it is not comprehendible to process medication orders today without the use of a computer system to check for drug-drug interactions, drug-allergy interactions, dose range checking, and appropriate route of administration screening. The use of a computer system for medication profiling and assessment is an expectation in the pharmacy industry (ASHP, Minimum Standards 1995). It seems logical that decision support would be even more important to the physician since they make the final decision in regard to all aspects of patient care. Evidence exists that a CPOE system improves physician performance and decreases adverse drug events (Johnston et all, 1994). David Bates MD, et al published a study in JAMA (1998) that investigated medication error data before and after the implementation of a CPOE system. The results illustrated that the CPOE system decreased significant medication errors by more than half. CPOE has also been studied in relation to decision support for cost containment and appropriate use of medication for standard care of patient. Jonathan Teich, MD, et al published results of a study in the Archives of Internal Medicine in 2000. The study results illustrated that the use of one cost saving medication increased by 65% with the program. The system accomplishes this by providing the practitioner decision support information during the order entry process. For example, there are four medications called proton pump inhibitors in a class of medications that decrease acid secretion in the stomach. These four medications are very similar in safety and efficacy and are widely felt to be interchangeable with each other. If the hospital is able to acquire one of these agents at a significantly lower price, the physician could be notified

of the potential for cost savings when any one of the higher cost proton pump inhibitors is selected from the CPOE system.

CPOE systems also have the ability to provide dose range checking. This function provides guidance to the prescriber when the medication ordered is above or below the usual dosage for the corresponding patient.. Teich et al (2000) showed that orders for doses that exceeded the maximum recommended doses decreased from 2.1% to 0.6% of orders with the CPOE system. The use of a medication to prevent blood clots in the legs of hospitalized patients went from 24% to 47% with the aid of this decision support tool.

At first glance, it would seem that CPOE should be a part of every health care organization in the country. There are many challenges with CPOE as well. The cost of the technology and the infrastructure needed is significant and prohibitive to many health care facilities. The estimated cost to implement a CPOE system in a 200 bed hospital is $4.4 million in up-front fees with $500,000 in annual expenses (Williams, 2005). The American Hospital Association (2005) estimates the cost to implement a CPOE system at a 500 bed hospital at $7.9 million and the annual maintenance cost of $1.35 million. CPOE is not as flexible as a pen and paper for initiating orders in a complex environment that interfaces with many non-routine situations each day. For example, there are times that directions are longer than the number of characters allowed in the direction field. Users of CPOE need to develop clever methods, called a work around, for getting things done the system will not allow you to do easily. In the example of the lengthy directions, a note could be put in the medication direction field to see another section on the computer that allows for longer free text messages (Ash et al, 2003). The use of CPOE will also dramatically change the way physicians perform their duties on a daily basis. The

concept of changing physician behavior and practice alone can be a reason to not implement a process improvement strategy due to the formal and informal power this group of health care professionals has in health care.

Physician and administrative leadership needs to fully support the concept of CPOE before the implementation. Physicians are human beings and are resistant to change like any other person. Due to the power they possess, successful implementation of CPOE hinges on perception of these stakeholders. A study by Weiner, MD et al (1999) showed that physicians and nurses had different views about the effects of CPOE on patient care. Most nurses saw a beneficial effect whereas the majority of physicians saw a negative effect. The nurses were more positive about CPOE because it decreased their time interpreting handwritten orders. In addition to greater order clarity, the orders were more organized and easier to execute. Both of these improvements freed up nursing time to be spent with patients. The majority of nursing staff also perceived that there were less errors because of the CPOE system. Many physicians felt the CPOE system caused them to spend more time entering orders and allowed for less time with patients. A majority of the physicians felt the CPOE system increased the number of errors. There is no doubt that new processes and new technology can cause new types of errors to emerge (Bates, 2001).

Another study published in the American Journal of Informatics Association in 2003 was conducted by Joan Ash, PhD et al to evaluate perceptions of a CPOE system. The study results supported that there are going to be significant implementation challenges. However, these challenges can improve team dynamics and cause a greater interdependency on each other. The results also illustrated a power shift away from physicians and to the staff at the health care

organizations. This occurred partially due to the fact that nursing staff mastered the order entry process sooner than physicians. The physicians then relied on the nursing staff to help them enter orders. The orders were much clearer as well. This decrease in ambiguity decreased the number of frequent phone calls from nursing to physicians for simple clarifications. This seemed to improve the relationship between nurses and physicians. Also the system electronically prompts nursing staff to execute orders. This caused orders to be carried out much faster than previously which also improved physician and nursing relationships. The role of the information system department in patient care increased significantly with the implementation of CPOE. Successful implementation appears to be impacted by ongoing collaboration and clinician engagement in the CPOE technology.

CPOE is not currently utilized at our hospital. I see the adoption of this technology having the greatest impact on improving health care services. Conversion to CPOE may be the greatest performance improvement challenge we will face in the next five to ten years. The utilization of CPOE will have a significant impact on the way physicians, nurses, and pharmacists perform their daily responsibilities. CPOE will decrease the amount of time pharmacists spend deciphering orders and inputting them into a computer system. More time will be needed to answer drug information questions from physicians and in the development of best practice guidelines for medication therapy (Murray, 2000). Changes are being made in the pharmacy department currently to start building the infrastructure and development of staff to be able to better adapt to the changes associated with CPOE. In the first part of 2006, the majority of the order entry process completed by pharmacists in the inpatient pharmacy will be performed on the nursing unit by a larger number of pharmacists. This process change will begin the development

ORDER TRANSFER PROCESSES

Orders can be initiated using pen and paper, preprinted order forms, or through CPOE. However the order is generated, it must be received by the pharmacist for review and processing. Orders that are handwritten may be generated on a duplicate order form with the one copy for the pharmacist. Frequently this duplicate copy is even more difficult to read than the original. Faxing handwritten order forms to the pharmacist is also widely used. The faxed image is often of poorer quality than the original order (ASHP, Technical Assistance 1980). A recent technological advancement is the use of a fax imaging system to receive orders. This system works similarly to the faxing process. The pharmacist receives an electronic image of the order instead of a paper copy. The system allows for the pharmacist to magnify the image to assist with clarification of orders. The system also allows the pharmacist to electronically document information about the order and to archive all of the orders in a way that allows for prompt retrievabilty of the numerous order sheets received every day. The imaging system also allows for flexibility for completing the order processing work. When all orders are sent to a central fax machine, the order processing will usually occur in the location of that fax machine. The fax imaging system allows for the review of all orders in any location the terminals are positioned. This flexibility will allow for placement of the pharmacist and order processing in the part of the hospital where it is best for patient care.

Pharmacists processing orders should have access to appropriate clinical information, allergies, pregnancy status, lactation status, renal status, and diagnosis (ASHP, Preventing Medication Errors in Hospitals 1993). It is felt that one of the most common system failures is in disseminating drug knowledge and in making drug and patient information readily accessible at

the time it is needed (Manasse and Thompson, 2005). What better place is there for the pharmacist to process orders than on the patient care units where they have face-to-face access to nurses, patients, and physicians in addition to the patient chart? The medical center currently uses a fax imaging system for order retrieval but less than 5% of the orders are processed on the patient care units at this time. A process improvement to increase the number to approximately 75% of the orders being processed from the patient care units is currently being planned.

REVIEW OF ORDERS BY PHARMACISTS

One of the ASHP's goals to be achieved by 2015 is to have 85% of routine medication orders reviewed by a pharmacist before the first dose is administered. Due to the nature of a hospital setting, many medications are available to nursing staff in floor stock that could be given without prior review by a pharmacist. The Joint Commission also requires routine medication orders are reviewed before administration to a patient (Rich, 2002). The philosophy behind this expectation is that when a pharmacist is part of the medication use process it is safer for patients. The system is improved because there is another health care discipline reviewing the order for drug-drug interactions, drug-allergy interactions, appropriateness of dose, and appropriateness of the route the medication is administered. The pharmacist is also using a computer system which provides decision support to assist with this process.

Four areas in the hospital have been identified that do not have routine orders reviewed by a pharmacist before administration. These areas have relatively low medication order volumes but still are not in compliance with this expectation. Process improvements are in place to have two of the areas being reviewed by a pharmacist by the end of 2005 and the review process for the other two areas will occur in the first quarter of 2006. This is a very significant

cultural change for both the patient care area and the pharmacy.

## ORDER ENTRY SYSTEMS

The pharmacy order entry systems should be able to check for appropriateness of dosages, drug-drug interactions, drug-allergy interactions, and duplicate therapy (ASHP, Preventing Medication Errors 1993). From my perspective the system should also provide pregnancy, lactation and kidney function status of a patient. The system should also be able to be programmed to monitor changes in lab values that may impact the medication therapy and prompt the pharmacist to address these issues when they occur.

The pharmacy department has just implemented a new pharmacy computer system that has the most advanced technology available at this point. This complex computer system has many functions that have not been explored yet. It is very important that the department continues to develop performance improvement strategies with the use of this vital piece of technology. Some of the areas that need investigation and implementation are in the use of tall man lettering to help prevent medication mix ups, development of rules that review medication therapy in the background and then prompt the pharmacist via an electronic work list, calculation of medication drip rates with the computer system, utilization of the documentation component to enhance communication amongst the pharmacists, and utilization of the functionality that notifies the pharmacist when a medication was removed from the nursing unit without prior review by a pharmacist.

## DOSE RANGE CHECKING

Dose range checking is one of the current functions of the order entry system that the department has just started to use. Dose range checking works by the computer system evaluating

the age of the patient and the dosage entered. If the dose is outside the range built into the computer system data base, the pharmacist will be notified of this variance. The previous computer system had this functionality as well but the implementation of the functionality was not embraced by the information systems pharmacist and was not implemented. This functionality requires a large amount of analysis in designating what are acceptable dose ranges. Once that work is completed, the system will allow for ongoing assistance in providing decision support to all staff using the system.

HIGH RISK MEDICATION

High-risk or high-alert medications are ones that are involved in a high percentage of medication errors or are ones that have a higher risk for abuse, errors, or other adverse outcomes (JCAHO, Standards 2005). The hospital is required to review the recommendations of safety groups like ISMP to determine which medications on formulary are high-risk medications. The hospital is also required to develop processes that are anticipated to decrease the chance an adverse event happens with these high risk medications. The safety processes may vary from medication to medication. Chemotherapy orders are known to carry a higher risk of adverse events than other medications. ASHP guidelines have been published for the safe use of this type of medication (ASHP, Antineoplastic Agents 2002). Staff administering chemotherapy should receive special training. Orders for chemotherapy should be clearly written by using preprinted order forms when possible. Abbreviations and verbal orders should be prohibited with chemotherapy orders. Independent double check processes should be put into place at both the preparation and the administration side of the process. Another recognized focus area is in the pediatric arena. Medications have a smaller margin of safety in this population because even

small amount of excess medication given to a pediatric patient may be very high proportionately to the small size of the patient (Lucas, 2004). All dosages and routes of administration in pediatric patients should be double checked by two health care professionals (Cohen, 1999).

The hospital has a policy designating which medications are classified as high risk. One strategy for improving safety is to store certain types of medications only in the pharmacy. This is done with concentrated electrolyte solutions that cause patient death when administered as an undiluted solution to a patient. The most common approach to improving the safety of high risk medications is by implementing an independent double check process into the system. For chemotherapy orders, this double check process is expected in the pharmacy and at the nursing station before medication administration. All orders for pediatric patients are processed by one pharmacist and then double checked by a second pharmacist as well. This process was formalized in the last two years. The pharmacy has also classified medication drips of concentrations other than the standard concentration as high risk. The medication error reduction strategy in place is for the pharmacy to affix a colored label to any medication drips that are double, triple, or quadrupled in concentration from the standard concentration (Rich 2002).

The evolution of categorizing high-risk and high-alert medications is in its early stages. The list of medications in this category is extensive and continues to grow. Strategies for error prevention are changing as well. At a minimum, the department needs to assign the responsibility of ongoing review and analysis of this class of medications. This team would also be responsible for assistance in implementation of process improvements that are designed to make the system safer.

## ORDER REVIEW BY NURSING

The incorporation of independent double checks into a system is a strategy that should be incorporated as much as possible into system design. For example, much of the medication collection and preparation in the pharmacy is performed by a pharmacy technician. Before the medication is sent to the patient care unit, the medication is checked by a pharmacist. This process builds in two individuals into the system. For over a decade, the medical center has utilized a similar scenario for medication orders. The pharmacist enters the medication order into the pharmacy computer system. At midnight a complete listing of the medications the patient is to receive the next day is generated on the patient care unit. The nurse is responsible for checking the accuracy of the new printout compared to the changes that had occurred in the previous day. Recently some medication errors that should have been caught by this process have occurred. The system was evaluated and it was identified that the double check process is not being performed consistently across the medical center. This may be caused by the lack of a policy and procedure on how to perform this function. This lack of documentation on what is expected of the staff has allowed for variance in practice to occur over time. In addition to lack of consistency, appropriate training on the process has not been completed with new hire training or through refresher training for existing staff. Nursing administration in conjunction with pharmacy administration is scheduled to improve this process.

## PATIENT TRANSFERS

Order processing during patient transfers to a different level of care has been identified as an area where a significant number of medication errors occur (Rich, 2002). Identification of medication orders following surgical procedures is of great importance because of the changes

that occur during the perioperative period (Pass and Simpson, 2004). Different levels of care occur when a patient migrates through the health care setting. For example a patient may enter through the emergency room, be admitted to an acute care bed until it is decided the patient requires surgery. The patient then goes to the operating room for a procedure and then back to the acute care bed for several days. The patient may then be transferred to a lower acuity unit for several days before being discharged to home. Getting physicians to provide a clear list of medication orders a patient is to continue at different levels of care has been challenging because documenting this list of medications is time consuming. The Joint Commission had made providing a clear list of medication orders a JCAHO National Patient Safety Goal for 2005. Full implementation of this goal is expected by January of 2006. The medical center currently has a multi-disciplinary performance improvement team working on this project.

Benjamin (2003) calculated that transcription errors account for about twelve percent of all the medication errors in hospitalized patients. The discussion about order processing encompassed much more than basic transcription but this does give us a sense relative value when focusing process improvement efforts on the order processing area of the medication use system. The next section on dispensing, preparation, and procurement also have been shown to have lower overall percentage of hospital medication errors occurring in this area. Benjamin (2003) estimated dispensing errors are at about fourteen percent of all medication errors that occur in a hospital.

## DISPENSING, PREPARATION, AND PROCUREMENT

With over 2,700 line items of medications available for use in the medical center and twenty-five patient care areas utilizing medications in a complex environment, several different

dispensing processes are needed to meet the needs of the organization. The discussion about dispensing will first review the general processes of central fill, automated dispensing cabinets, floor stock, and intravenous medication preparation. The review will then cover topics of unit dose preparation, labeling, and acquisition of ready to use forms of medications.

The balance between controlling prescription medication and having the medications available in the areas it is needed is challenging. The central pharmacy acts as the warehouse and distributor of the medications to all the areas in the hospital where medications are needed. From the central pharmacy, medications are provided to the hospitalized patients, nursing unit floor stock, operating rooms, emergency rooms, procedure rooms, and clinics. The way these medications are stored in each area is an important aspect of total medication safety and control. The environmental factors of temperature, light, and humidity conditions are important considerations in maintaining integrity of the medication. The expiration dating on the medication needs to be monitored on an ongoing basis to ensure the medication is still able to be used (ASHP, Technical Assistance Bulletin 1980).

CENTRAL FILL

One of the major components of the drug distribution process is providing the medications to the hospitalized patients. The traditional process is to manually collect the supply of medications the patient needs for a specified time period and then have that supply of medications available on the nursing unit in a secure location for the nurse to administer to the patient. In the last decade, robotics and automated dispensing cabinets have allowed for the evolution of this time consuming process.

Robotic systems utilize computer interfaces and bar code technology for collecting the

medication supply needed for the patient. The robotic system can also check for the integrity of the medication since the expiration date of the medication is built into the bar code on the medication. The robotics system takes a lot of the human factors out of the mundane process of handpicking and checking medications. The robot is also used to return medications to stock that were not needed. The utilization of the technology takes away the possibility of placing the stock back into the wrong bin on the shelf. Robotics systems also can be utilized for the assisting in the billing function. The bar code on the patient name sticker and on the medication are used to adjust the patient bill appropriately.

## AUTOMATED DISPENSING CABINETS

Some hospitals utilize automated dispensing cabinets for the majority of the supply they need for their hospitalized patients. These cabinets have the ability to hold a large number of medications in a secure environment on the nursing units. The nurses get the majority of medications for the patients out of the automated dispensing cabinet. This type of process removes much of the control of medications if not set up appropriately. Technological advancements in the automated dispensing cabinets are available to ensure proper control and safety. The most significant safety advancement is the ability of the cabinet to not allow the removal of a medication by a nurse before the medication order has been reviewed by a pharmacist (ASHP, Safe Use of Automated Dispensing Medication Storage 1998). When utilized appropriately, this function can allow for all the safety and control of housing the medications in the central pharmacy and with the convenience of having the medications available in the nursing units.

FLOOR STOCK

Each nursing unit requires stock of controlled substances for pain control and medications for minor procedures performed by the physician in the patient room. Floor stock should be limited to what is needed on the nursing unit. The floor stock should be reviewed on an ongoing basis to ensure only required medications are currently stocked on the floor. Automated dispensing cabinets can also used to manage controlled substances and other floor stock items (ASHP, Technical Assistance Bulletin 1980).

The hospital currently utilizes a central fill process for the majority of the medications needed for the hospitalized patient. A robotic system is used for the collection of this medication supply. The use of this technology has decreased the manual picking down to approximately 10% of the total supply delivered. A daily quality assurance process is in place to make sure the robotic system is accurate in its process. The robotic technology has also allowed for the redistribution of pharmacist and pharmacy technician resources to other more cognitive functions. The hospital also has nineteen automated dispensing cabinets that are used on the nursing units to manage controlled substances and floor stock items. Currently the hospital is not utilizing the control function of the automated dispensing cabinet. A review of medications that are being removed without pharmacist review needs to be conducted on an ongoing basis. Process improvements need to be put into place on how to eliminate the removal of a routine medication without pharmacist review. A listing of medications that cannot be taken out of the automated dispensing cabinet needs to be developed by a multi-disciplinary team and approved by a medical staff committee. Floor stock items are reviewed on an ongoing basis by a pharmacy committee. This committee also reviews all new requests for addition to floor stock. One

improvement identified is to add a nurse representative to the committee to bring nursing perspective to the committee.

## MEDICATION PREPARATION

### INTRAVENOUS MEDICATIONS

The preparation of sterile intravenous medications is an important part of the medication control system. The pharmacy is responsible for assuring the that all sterile intravenous medications are free from microbial contamination, free from unacceptable levels of particulate matter contamination, correctly prepared, and properly labeled (ASHP, Technical Assistance Bulletin 1980). The Joint Commission requires the pharmacy to prepare all sterile medication, intravenous admixtures or other medications unless it is an emergency situation or the medication has a short stability after being prepared (JCAHO, Standards 2005). The centralization of the process decreases variability from nurse to nurse in the complex process of admixing sterile medications. The processes are usually set up to have a specially trained pharmacy technician prepare the medication and then have the medication double checked by a pharmacist. The preparation also occurs in a much cleaner environment in the pharmacy than occurs on the nursing unit. In the pharmacy there is an area dedicated to sterile medication preparation. The use of a laminar air flow hood is the standard. This type of hood allows for clean air flow across the surfaces of the products which decreases the chance of microbial contamination during the admixing process. The United States Pharmacopeia has recently updated Chapter 797. These new revisions are very rigid guidelines that need to be adhered to for compliance when these products are prepared in the pharmacy.

The hospital prepares the vast majority of the sterile medications in the pharmacy. There

are a couple of patient care units in the hospital that prepare some of their sterile medications in their areas. These areas are the labor and delivery unit, emergency room, and the neonatal intensive care unit. The conversion for sterile medication preparation to the pharmacy was initiated for the labor and delivery unit in the Summer of 2005. Final implementation issues are being finalized. The emergency room has just initiated the process improvement planning process for this change and is planned to start implementing in December of 2005. The neonatal intensive care unit will begin the planning process in the first quarter of 2006.

UNIT DOSE MEDICATIONS

Studies have established unit-dose drug distribution systems reduce the incidence of medication errors (Cohen, 1999). This type of system is built to provide double checks in the process to increase the likelihood that errors will be caught. For example, the majority of the unit dose preparation is done by a pharmacy technician. Their work is then inspected by a pharmacist before the product is allowed to be used for patients. Even though unit dose systems may vary to a slight degree from hospital-to-hospital due to specific needs, the unit dose system should include four basic fundamentals. First, medications are contained in a single unit or unit dose package. This can take the form of one tablet in a small plastic package or a liquid in a small cup with a paper lid. Second, medications are dispensed in ready-to-administer form extent as possible. This process centralizes product preparation to the pharmacy where specially trained staff perform this function. Third, only a twenty-four hour supply of doses is provided to or available at the patient-care area at any time. The limitation of product availability to only what is needed in a short segment of time decreases the chance that a medication will be given in error. Fourth, a patient medication profile containing patient demographics and a list of the current

medications the patient is receiving should be maintained by the pharmacy (ASHP, Technical Assistance Bulletin 1980).

The hospital has been utilizing a unit-dose system for many years. Even though this concept has been deployed for the majority of medications dispensed, there are some areas that are in need of refinement. The liquid medications were being dispensed to the floor in sixty milliliter bottles when most of the doses were five milliliter doses. An initial step was taken in the Summer of 2005 to improve this process. We are now encountering implementation challenges with more five milliliter doses in the system. One of the challenges is to identify a label that is capable of adhering to the container that has been chosen for this process. The label options are limited because the label has to be able to have a bar code printed on it. The other challenge is around monitoring of the expiration of these items. Once the medication is removed from the manufacture's package, it is only stable in the unit dose package for six months. This shorter expiration time frame and larger number of items to evaluate required additional process improvements to the expiration date checking process in place in the pharmacy. A small number of injectable medications are being dispensed to the nursing units that require some preparation by the nursing staff that should be performed by the pharmacy. An evaluation of these medications needs to be completed and preparation of them be done in the pharmacy.

Labeling

Names of medications that look or sound alike increases the chance a medication error will occur (National Coordinating Council, Error-Prone Aspects 1999). The Food and Drug Administration attempts to minimize this problem during the medication approval process. They interface with patient safety organizations to assist with the development of names that are not

problematic (Manasse and Thompson, 2005). Even though these processes exist, there are still problems that arise or there are medications that have become available before this focus on the name of the medication. An example of two medications that can easily be mixed up are hyralazine and hydroxyzine. Both can be given by the oral and injectable route of administration. Common dosages for both medications are 10 mg, 25 mg, and 50 mg. Since both medications have similar dosages, the dosage does not provide a distinguishing characteristic of the two medications either. A common cause of name mix-ups occurs when the practitioner confronted with a poorly written order may see the name with which they are most familiar with and may overlook any evidence to the contrary. Human factor experts classify this as confirmation bias (Cohen, 1999). Computer systems can reduce the risk of drug mix-ups by being programmed to provide prompts to staff when a look-alike or sound-alike danger is present. To get to the point of programming a computer system with this information, first an extensive evaluation of the current medications on the formulary in comparison to the literature of look-alike and sound-alike problems needs to be performed. Then strategies need to be developed to help prevent these errors from occurring.

The hospital has developed a look-alike and sound-alike medication policy. This policy identifies medications on formulary that may be problem-prone and contains the strategies currently being utilized to help prevent mix-ups. Surveillance for problems with look-alike and sound-alike medications needs to be completed on an ongoing basis. This role has been assigned to a single pharmacist. Since medications are stored on many units across the medical center and administered primarily by nurses, I believe that this ongoing surveillance and process improvement in this area should also include a member from nursing. This small multi-

disciplinary team needs to develop a process to continually evaluate this hazard and a process for ensuring the policy is being implemented at the hospital.

Human factors can play a significant role in errors associated with labeling of medications (Manasse and Thompson, 2005). The way information is displayed on a label could lead to errors. There should be collaboration among health care professionals, health organizations, patients, and the industry to facilitate the design of packaging (National Coordinating Council, 1998). Tall-man lettering is a principle to minimize medication errors. An example of a mix-up has occurred many times between dopamine and dobutamine. Both of these injectable agents can be used for similar reasons but have different characteristics and dosages. Tall-man lettering has been employed by the manufacturers of these medications due to Food and Drug Administration requirement. When purchased, the labeling for these agents are displayed as DOPamine and DOBUtamine. The capitalization of a part of the word draws more attention to the name of the medication and helps prevent medication errors. Newer computer technology has the capability of incorporating tall-man lettering into the system so this type of differentiation can be built into the many steps of the medication use system. For example, CPOE and pharmacy computer systems can have the formulary listing built with tall-man lettering to help prevent the wrong medication from being picked from the medication listing at the time of order entry. The medication information on the medication administration record should contain tall-man lettering as well to assist the nursing staff in selecting the correct medication. Unit-dose packaging equipment now has the capability of incorporating tall-man lettering onto the package prepared by a hospital.

Another less complex labeling issue to prevent medication errors is to label all products

immediately after they are removed from the original container. This concept might sound simple but unfortunately it is a step that is frequently bypassed by nurses to save time. Labeling the new container will prevent mix-ups in giving the wrong medication to a patient. The operating room is an area that has generally not implemented the practice of labeling items immediately upon removal from the original container. Many operating rooms do not have direct pharmacist involvement (ASHP, Surgery and Anesthesiology 1998). The Joint Commission has made the labeling of all medications in the operating room after removal from the original container a National Patient Safety Goal for 2006.

The hospital has an informal process for reviewing medications that may be mixed up due to labeling similarities. This process has improved over the last several years, but needs further refinement by developing a small team to be responsible for this review. The team needs to have a good understanding of the human factor principles in this area and should evaluate new medications brought into the system. The pharmacy computer system, the automated dispensing cabinets, and the unit dose packaging equipment now all have tall-man lettering capabilities. None of the systems have been developed at the hospital to include this information to assist with making the system safer. This process improvement needs to take place in the next six months. Medications removed from the original container are always labeled in the pharmacy. Nursing staff however bypass this process at times. An analysis of medications prepared on the patient care units should be completed to evaluate what types of medications this could be occurring with and develop a process improvement plan to prepare and label those medications in the central pharmacy. The review of intravenous medication admixture on the patient care units will yield the majority of items that may not be labeled appropriately and that these two

evaluations should be done simultaneously. A performance improvement team needs to be established to meet the 2006 National Patient Safety Goal for labeling of medications in the operating rooms.

Recently, the decision to change the process for flushing intravenous catheters was implemented. Historically, the nursing staff member would draw up the intravenous catheter flush from a stock bottle and then flush the catheter. Many times these syringes were not labeled with the contents of the syringe. The decisions was made to purchase the solution for the intravenous catheter flush in a prefilled syringe. This product is already labeled and bar coded from the manufacturer. It is estimated that over 90,000 of these prefilled syringes will be used annually at the medical center. This one change will significantly decrease the number of medication containers not properly labeled at the medical center each year.

## MEDICATION PROCUREMENT

### READY TO USE PRODUCTS

When medications are purchased from the manufacturer in the most ready-to-use form possible, medication errors are decreased (Manasse and Thompson, 2005). This has even greater importance in the area of sterile intravenous admixtures. Even though pharmacies have double check systems in place, mistakes are still made in the compounding process periodically. Manufacturers take a lot of the human factors out of a process when they are mass producing medications. They also have a rigorous quality assurance process in place to ensure the integrity of the product produced. Michael Cohen recommends the purchase of ready-to-use forms of sterile intravenous admixtures whenever possible to decrease the chance of errors being made in the preparation phase (Cohen,1999)

Many of the products used at the hospital come premixed in a ready-to-use format. There currently is not any process in place to do a reassessment on a scheduled basis to see if products have become available in ready-to-use format from a manufacturer. Historically, cost was a key decision maker on whether we would carry a ready-to-use format of a medication versus the pharmacy admixing and labeling the item. As the focus on safety and the knowledge of human factors principles evolve less weight should be placed on cost and more on safety when making formulary decisions (Cohen 1999).

There is no doubt that pharmacists have opportunities to improve the processes in which they work to decrease medication errors around the order processing and dispensing arenas. It is important to note that the greatest impact on improving medication safety is by making improvements in way physicians prescribe medications. The second greatest opportunity for improvement in the medication use system is in the nursing administration area. Benjamin (2003) calculated that approximately thirty-eight percent of all the medication errors that occur in hospitalized patients occurs during the medication administration process.

## MEDICATION ADMINISTRATION

Processes in health care systems have been described as being either blunt or sharp. The blunt end deals with all the processes surrounding health care delivery before the service is directly administered to the patient. The sharp end of health care delivery system is the point where care is delivered to the patient. In most cases with the medication use system, nurses are the professionals delivering the medications at the sharp end of the system (Morath, 2000). The basic components of administering a medication are to ensure the patient is receiving the right medication with the right dosage via the right route at the right time. These are known as the five

process is only partially effective since not all patients are able to comprehend the conversation or communicate back their concerns. The Joint Commission recently implemented a National Patient Safety Goal around the concept of making sure health care providers use two patient identifiers when administering medications. This goal requires the nurse to not only check the patient wrist band but also to use a second identifier like verifying the date of birth of the patient to ensure they are treating the correct patient. The use of bar code technology can take the human factors out of the process of patient identification. Before medication administration occurs, the nurse is required to scan the patient bar code located on their identification band (Institute of Medicine, 2000).

The hospital currently has a policy and procedure in place to ensure that two patient identifiers are used during the medication administration process. Since the adoption of this policy, wrong patient medication errors have still occurred. The hospital is conducting a trial on a nursing unit with the scanning of the patient's identification band. Several implementation challenges have occurred. New patient identification bands that were able to be printed on printers capable of printing bar codes were needed. Once the decision was made for the printer to purchase, the process for making patient identification bands was centralized to the admitting department due to the need of these specialized printers. Then it was identified that the scanners in the patient rooms did not have long enough cords to reach the patient when the patient was located at a distal point from the computer and scanner. Another challenge occurs when the patient is sleeping and an intravenous medication is administered. Historically, the patient did not need to be disturbed but now may need to be moved to gain access to the bar coded identification band. Scanning of the bar coded identification band also requires additional steps.

Some hospitals require a double check by another nurse for certain high-risk or high-alert medications. This type of double check system has been shown to significantly decrease the chance of medication errors from occurring (Husch et al, 2005). Even though this system is effective, it would not be practical to have all medication administrations undergo this double check process. It is my assessment that this process should be reserved for the high-risk or high alert medications. If too many double checks are required, nursing staff may not perform this process routinely.

The hospital currently requires a double check with anticoagulants, chemotherapy, insulin products, and patient controlled pain pumps. A second nurse is required to verify these medications are correct before the medication is administered and to document this verification on the medication administration record. Other strategies utilized for high-risk and high alert medications are standardizing intravenous medication solutions (Cohen,1999). When the medication has a higher concentration than the standard solution, the medication is flagged with a special label indicating the concentration. The hospital has a policy on handling investigational medications. The pharmacy is involved with the process when an investigational agent is utilized.

## BAR CODE TECHNOLOGY

The greatest technological process for improving medication safety during the administration phase is the utilization of a bedside point-of-care system (Bridge Medical, Pros and Cons 2003). This system works by scanning the patient identification band and the medications to be administered. The system then interfaces with the pharmacy computer system

to check to make sure the five rights of medication administration are occurring. If there is something in error, the nurse will receive a prompt to investigate the potential problem. This type of system virtually provides an independent double check for all medications without any human factors involved. This bedside system has been shown to decrease medication errors at the time of medication administration by 65 percent to 86 percent (Neuenschwander et al, 2003). Only a small percentage of hospitals currently utilize bedside point-of-care systems at this time.

The hospital was an early pioneer in bedside point-of-care systems and has been working this technology for over a decade. Even though the concept has been in practice at the hospital for many years, this technology is not utilized throughout the hospital. There are three major patient care units not using this technology. The respiratory therapists have recently started to utilize this technology when they administer respiratory medications. There have been barriers to successful hospital wide success. Some of the barriers have been problems with the technologies that occurred over time. Since the process was initiated years ago, there were many problems with the early technologies. Some of the problems included computers that did not function routinely. Interface problems occurred between the pharmacy computer system and the bedside point-of-care system. The pharmacy did not provide bar codes on all medication products either during the first years of implementation. When problems arose, communication breakdowns occurred between users of the system and system administrators. These types of problems are common for early adopters of this technology (Bridge Medical, Lessons Learned 2003). Many of the problems pioneers of bar code scanning experienced are already starting to resolve themselves.

Even though the technologies were in place for years, only recently did it seem like

hospital administration was focusing on this technology. The Board of Directors has recently made this safety practice a key priority. They have requested ongoing bar coding percentage rate information as one of their dashboard indicators. The technologies have recently been updated to the newest versions on the market and there are process improvement teams in place working through implementation issues. The three remaining units are scheduled to go live on this technology in 2006.

INFUSION PUMPS

Approximately 90 percent of hospitalized patients receive medications via the intravenous route. Intravenous medications have led to considerable patient harm and occur frequently (Husch et al, 2005). Smart technology now exists with intravenous medication pumps. Smart technology refers to intravenous pumps that have software programs for checking doses of medications against preset limits specific to the drug. The limits are either soft or hard limits. The soft limits provide a warning to the health care professional but are able to be overridden. Hard limits will not allow the health care member to program a pump outside this limit (Husch et al, 2005). Some of the pumps have the capability to collect the data about soft and hard limit encounters. The analysis of this data may help with process improvement initiatives for patient safety.

The hospital currently is utilizing older intravenous pump technology without any smart software capabilities. There are also several different pump types in place for different types of situations. The hospital will be implementing new intravenous pump technology in the next eighteen months. The incorporation of a pump with smart technology and the minimization of pump types is an important part of the decision making process.

Improving the administration system can have a significant impact on improving patient safety. Even though the literature identifies this process of the medication use system as the area that has the second largest percentage of medication errors, it is important to evaluate all the systems in your own hospital for developing process improvement strategies. Internal monitoring not only will provide information on what to do in your hospital, it will also take away the excuse that this issue does not happen at our hospital because you will have data showing it does happen.

## MEDICATION MONITORING

Ongoing evaluation of the medication use system needs to be done to continually improve it. The Joint Commission expects hospitals to evaluate their medication management systems for risk points and opportunities for improving safety (JCAHO, Standards 2005). This evaluation can be accomplished by the following processes: evaluation of medication errors, evaluation of adverse drug reactions, failure mode and effects analysis, medication use evaluation, and the development of a quality assurance program.

## MEDICATION ERRORS

Medication errors can take on many forms and be caused by virtually anyone working in the medication use system. Medication errors encompass both errors that are made but do not actually reach the patient and errors that result in incorrect administration of a medication to a patient. Medication errors can be categorized into the general categories of prescribing, dispensing, medication administration, and patient compliance errors. Prescribing errors can be due to incorrect drug selection, dosage, route of administration, rate of administration or illegible handwriting. Dispensing errors occur when the incorrect medication, dosage, or dosage form is

prepared and dispensed to an incorrect patient. Administration errors can include the patient receiving the incorrect medication, dosage, at the wrong time or via the wrong route. An error of omission occurs when a patient does not receive a medication they are intended to get. Inappropriate patient behavior regarding adherence to a prescribed medication regimen is also considered an error (ASHP, Guidelines on Preventing Med Errors 1993).

Ongoing performance improvement programs for monitoring medication errors are needed. Medication errors need to be identified, documented, and analyzed for their causes in order to reduce the chance of their re-occurrence (ASHP, Guidelines on Preventing Med Errors 1993). Typical reporting processes for medication errors only capture a small percentage of the errors that actually occur (Institute of Medicine, 2000). The number of errors reported is not as important as the evaluation and follow-up to the medication error. It is also important to understand that the evaluation of the error is much more labor intensive than the generation of the medication error report. Being able to do a good analysis also requires good information on the events that surrounded the error (Institute of Medicine, 2000).

The hospital has had a medication error reporting system in place for many years. When a medication error occurs, the person identifying the error is responsible for documenting the error and submitting that to their supervisor. The supervisor in the area is to review the error and take corrective action if necessary. The report then goes to the pharmacy for evaluation and documentation into a database. On a monthly basis, each unit receives a description of the errors that occurred in that particular area. The error reporting and analysis system has the infrastructure needed for a successful program. There may not be enough resources working on the analysis of the error data and process improvement formulation. It is very difficult to determine how many

resources to shunt towards this analysis. The organization should review the entire process for medication error documentation and analysis structure to determine opportunities for developing a medication safety team. A medication safety team should include the five following responsibilities: building and fostering a safety culture within the organization; improving and maintaining effective error reporting systems; reviewing high-risk medications and processes; actively engaging practitioners in improving medication use systems; and ensuring regulatory compliance to patient safety standards (Manasse and Thompson, 2005).

ADVERSE DRUG REACTIONS

Adverse drug reactions are defined as any detrimental response to a medication that is undesired, unintended, or unexpected. As defined by the World Health Organization, adverse drug reactions exclude events associated with errors while adverse drug events include preventable and non-preventable events (Bates et al, 1999) This study by Bates et al evaluated risk factors which make patients more prone to adverse drug events. Their findings showed that adverse drug event diminishing strategies should be targeted on improving medication use systems and not looking for certain high risk patients and then developing processes for those groups of patients. A study published earlier provided similar findings (Leape et al, 1995). It was felt by the authors that the most appropriate way to decrease adverse drug events was to improve underlying systems. The authors felt that the greatest impact in preventing adverse drug events was to disseminate knowledge about drugs and to make drug and patient information readily accessible at the time it is needed.

The hospital has a process for collecting adverse drug event information. Once the data is collected, it is analyzed and presented to the Pharmacy and Therapeutics Committee. As with

review of medication error data, thorough review of the adverse drug event is very time consuming. Due to the complexities of the medication use system it is often difficult to identify strategies for making improvements in the system. When the strategies are more obvious, changes are put into place. For example it has been identified that one of the commonly used antibiotics causes low blood sugar in some diabetic patients. This adverse medication event has occurred at the hospital. The Pharmacy and Therapeutics Committee recently started to develop a policy that ensures that blood sugar monitoring occurs on all diabetic patients receiving this antibiotic. This monitoring will catch the potential decrease in blood sugar a patient may experience and allow for appropriate action if the event occurs.

FAILURE MODE AND EFFECTS ANALYSIS

A failure mode and effects analysis(FMEA) is a tool that can be used to evaluate a system before an error has occurred. The FMEA review looks at the various possibilities for failure and what are the potential consequences of each (Cohen, 1999) To conduct the FMEA, a multidisciplinary team analyzes a process for failure points. These failure points are then further analyzed for the types of errors that can occur from the failure point. Once that data is collected, each area has a numeric score determined by the group for how frequently the error could occur, the seriousness of the error, and how detectable the error is in the system. The numeric scores from these areas are combined. The failure points with the highest combined score are determined to be the highest priority areas to develop process improvement strategies. The Joint Commission requires healthcare organizations to perform at least one FMEA each year. In 2004, the hospital performed a FMEA on a large portion of the medication use system. The top areas identified for process improvement were ensuring all routine medication orders were reviewed by

a pharmacist before administration, increasing the utilization of bedside patient care system of scanning medications before medication administration, and standardizing the medication administration record reconciliation process at midnight. The medication administration record reconciliation process at midnight is the step by which the nursing staff double check the order entry work of the pharmacist. If this is not done consistently and accurately, an important double check system is bypassed.

MEDICATION-USE EVALUATION

Medication-use evaluation(MUE) is a performance improvement method that focuses on evaluating and improving medication-use processes with the goal of optimal patient outcomes. MUE may be applied to a medication or class of medications, a disease state or condition, or a medication-use process like dispensing or prescribing. There are multiple reasons to select a particular MUE: the medication is a high-risk medication; the medication use process affects a large number of patients; the medication or medication use process is one for which suboptimal use could could lead to a negative effect on patients; or the use of the medication is expensive (ASHP, Medication-Use Evaluation 1996).

There are certain indicators that may help hospitals identify what areas to perform a MUE. The adverse drug reaction and medication error reporting systems may provide information on medications or systems that are leading to problems. Signs of treatment failures like unexpected readmission rates of a particular patient type may identify problems within the system. Reviewing pharmacist intervention data may point to processes that are in need of improvement. This data is collected by pharmacists when they intervene with decisions made by a physician to improve patient care. Reviewing the requests to use medications not approved

through the formulary process and reviewing patient dissatisfaction surveys may also provide information on what areas to conduct a MUE (ASHP, Medication-Use Evaluation 1996).

Some common pitfalls may be ecnountered when conducting a MUE. It is important to ensure there is adequate authoritative support of the MUE process. A process that does not have medical staff or formal organizational support is likely to be unsuccessful. The MUE needs to be clearly developed with details on who will develop criteria, who will communicate with other departments, who will collect and analyze the data. Without the delineation of these responsibilities it is likely the MUE will stall during implementation. It is important that the events of the MUE be well documented and communicated through the appropriate channels. Often the MUE will be spearheaded by select individuals or a single department. The MUE should be developed through an interdisciplinary consensus process. This type of process will assist in making sure the MUE is accepted by the key departments affected and will assist in gaining the support of process improvement plans that are derived from the MUE. Another common pitfall is the lack of follow through on the MUE. A one time study conducted and a one time process improvement implemented is often not adequate. Assessment of the actions put into place should be done as well and action plans readjusted as necessary to achieve the patient care improvements (ASHP, Medication-Use Evaluation 1996).

The hospital works on multiple MUE projects on an ongoing basis. We encounter many of the pitfalls identified above as well. It seems like there are too many initiatives that are being conducted that it is difficult to remain focused and follow a process through to completion. The process is also very time consuming due to the number of individuals involved in the process and the number of patient care areas to implement the process improvement. Often the process

improvement is completed and then the staff is educated but ongoing assessment is not done to ensure the process improvement is successful or compliance to the new procedure.

QUALITY ASSURANCE

Each pharmacy should have an ongoing quality assurance program in place (Gray et al, 2004). This program should look at important aspects of the medication use system to determine the accuracy of the functions being performed and to identify opportunities for improvement. Cohen (1999) describes the importance of an ongoing quality assurance program around the preparation of intravenous medications. Often the preparation of these medications requires multiple calculations, multiple manipulations, and the utilization of equipment to make the medication. Due to the complexity and the potential for patient harm, Cohen feels this is an area that should have an ongoing quality assurance program.

The quality assurance program in place in the pharmacy needs to be improved. The monitors have been used for many years and most do not yield significant value in assessing critical components of the pharmacy operations. For example, one monitor is to ensure that the freezer temperature monitoring document is changed every Wednesday of the week. The freezer actually has an audible alarm that goes off when the freezer temperature goes outside a predetermined range. Monitoring the changing of the monitoring document is more a bookkeeping quality assurance than being important in a critical component of the pharmacy operation. There has been limited process improvement derived from any of the monitors for several years. This fact alone provides evidence that the current systems being monitored are working adequately and it is time to monitor other aspects of the operation (Gray et al, 2004).

The process of reviewing medication errors, adverse drug reactions, performing MUE,

and an ongoing quality assurance program should provide a hospital with data in which to target process improvement strategies. The complexity of the processes and the volume of data may make it difficult to determine what areas to work on first. It may also be difficult to focus on an area until adequate process improvements have been realized.

## CONCLUSION

This study provided an overview of general ideas about improving the safety of the medication use system. There is a significant body of literature available pertaining to the medication use process. Due to the volume, it was difficult to evaluate all the aspects of literature in specific areas. As each one of the process improvement ideas is being worked on, a narrower review of the literature pertaining to the specific area should be completed to ensure all details of the safety strategies are identified and reviewed for possible incorporation into the system.

This evaluation has provided the groundwork for the process improvement opportunities in the medication use system at St Alexius Medical Center. The major areas to focus improvement strategies are intravenous medication pumps, full implementation of a bedside point-of-care bar coding system for medication administration, decision support systems while performing prescribing order entry, and physician preprinted orders. These areas parallel the findings by Benjamin (2003) in which the greatest percentage of medication errors occur in the prescribing and administration phases of the medication use system. Several minor areas of improvement have also been identified as higher priority. These include ensuring routine medication orders are reviewed by a pharmacist before the medication is administrated, preparation of intravenous admixtures for the Neonatal Intensive Care Unit and the Emergency Room by the inpatient pharmacy.

Implementation challenges will be greater in areas where the changes in the medication use system affect more areas than just pharmacy. The physicians have significant power in the organization. This power impacts process improvement efforts that affect their daily routines. Making changes that impact over six hundred nurses is challenging as well. To be successful in performance improvement efforts, a multi-disciplinary approach in developing the plans will need to be utilized. The different groups of staff will be becoming much more interdependent on each other as patient safety strategies are implemented and performed on an ongoing basis at the medical center.

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