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Medication Errors in the Intensive Care Unit

Introduction

It is estimated that 1.5 million preventable adverse drug events occur annually in the United States (Institutes of Medicine 2006) and have led to 177 billion dollars in estimated costs (Ernst and Grizzle 2001). The intensive care unit (ICU) and emergency department (ED) are particularly complicated considering the level of patient acuity and frenetic work environment. As a result, it is difficult to pinpoint the problem areas and solutions necessary to avoid preventable medication errors in these settings. A recent study highlighted the risk of medication errors associated with parenteral drug administration in the intensive care unit (Valentin et al. 2009). This multinational study highlights error rates associated with the most common type of medication errors - administration at the bedside. Although medication administration accounts for most of the errors in the acute care setting, errors in prescribing, transcribing, preparing and dispensing medications also occur (Krahenbuhl- Melcher et al. 2007).

Studies highlight the consequences of medication errors in the critical care setting such as increased hospital length of stay, hospital costs, morbidity, and often mortality (Moyen et al. 2008). There is a fairly large body of literature surrounding the frequency and type of medication errors. This, however, represents only the tip of the iceberg. Many institutions struggle to capture the breadth of the problem because of their dependence on voluntary reporting through a reactive model triggered by adverse patient outcomes. Proactively identifying problem areas in the medication use process and recognising high risk patient populations can improve the safe use of medications in the ICU and ED.

Discussion Identifying the Problem Areas:

The Medication Administration Process

Critical care units are fast paced, interruption driven environments. Add to that the complexity of caring for patients with a wide range of critical illness, the presence of multiple care teams contributing to orders on a single patient, the large number of orders written per patient, and the use of high-risk medications, the atmosphere of the ICU is inherently primed for a medication error.

As described by Valentin et al, some of the patients most at risk for medication administration errors in the ICU are those with one or more organ failures, receiving multiple parenteral medications, units with increased patient to nurse ratio, and larger and mixed ICU types (Valentin et al. 2009). Interestingly, most of the errors occurred during routine care and less commonly during periods of extenuating or critical situations. Patients least at risk for errors were those where an electronic medical record was used, critical incident reporting was utilised, and routine checks at shift change occurred. It should be noted that more than 75% of the errors reported in this study were due to incorrectly timed or missed medication administration perhaps inflating the rates of medication errors reported compared to other studies.

High-risk parenteral medications are not only error prone, but are common place in the ICU (See Table 1 for a list of high risk medications). Many of these, such as vasoactive agents, are often life saving during the acute phase of critical illness requiring continuous IV administration delivery with a wide range of dosing needs based on several patient specific factors, such as clinical indication, patient size, age and organ function. Standardisation of drip concentrations and the use of smart pump technology are recognised strategies to help avoid the variability that lends itself to errors with the use of these agents. However, some studies have shown the ability of smart pumps to avoid serious medication errors may be limited (Nuckols et al. 2008 and Rothschild et al. 2005). It has been speculated that the effectiveness of smart pumps to reduce errors is dependent on the technology employed and the nurse training and behavioural changes necessary to integrate smart pumps into practice (Rothschild et al. 2005).

The use of bar code medication administration systems and unit dose medications can help provide additional safety measures to improve the medication administration process. A study in a neonatal intensive care unit (an area of high medication error rates) using a bar code medication administration system reduced the risk of targeted preventable ADE's by 47% and can improve patient safety during the medication administration process (Morriss et al. 2008).

Identifying the Problem: Medication Use in Transitions of Care (Medication Reconciliation)

Medication reconciliation is the process by which medication prescribing accuracy is ensured from one care setting to another or from one practitioner to another. Although not a new concept to the medical profession, there has been heightened awareness and intensified efforts in the past few years as a result of an evolving body of literature surrounding errors resulting from oversight of this process (Santell 2006).

Focus on the medication reconciliation process is often made at patient admission, transfer from level of care, and discharge from the hospital. Critically ill patients tend to transition through several levels of care while in the same ICU bed due to the dynamic nature of their critical illness. These constant changes require addressing the medication needs of both their acute and chronic conditions on a more frequent basis. Pharmacokinetic and pharmacodynamic changes that occur in the patient as a result of critical illness and medical interventions should be

routinely and systematically addressed in the care assessment and plan daily.

The number of co-morbidities seen in the ICU patient population lends itself to a long list of chronic medications needed for health maintenance. During the acute phase of critical illness, practitioners commonly hold chronic medications for a variety of reasons. Many of these chronic medications become contraindicated during times of haemodynamic instability and with organ dysfunction (particularly the kidney, liver and gastrointestinal track) and clinicians appropriately and consciously discontinue their use. It has been reported that as few as 12% of chronic medications are resumed by the time the patient is transferred out of the ICU to the floor (Campbell et al. 2006). Regardless of whether these medications were consciously or inadvertently held, the lack of documentation for addressing these medications during this transition of care may itself place patients at risk for unintentional medication discontinuation for baseline health needs when they are later discharged home (Campbell et al. 2006 and Bell et al. 2006). It is imperative to ensure proper communication with regards to appropriate timing for reintroduction of therapy and current dosing needs as we hand off the care of the patient from one practitioner to another.

Identifying the Problem: High Risk Patients

A review of medication related problems in acute care settings found the following populations at risk for adverse medication events: patients with polypharmacy, female sex, drugs with narrow therapeutic range, renal elimination of drugs, age greater than 65, and the use of anticoagulants and diuretics (Krahenbuhl-Melcher et al. 2007).

As previously discussed, patients in the ICU and ED have multiple preexisting morbidities and baseline medication maintenance needs. In addition, elderly patients have declines in compensatory reserves and an increase in the variability of drug effects and are therefore at higher risk for developing adverse drug reactions (ADR's). As well, polypharmacy is common in older adults making them more at risk for adverse events related to medications, possibly leading to an ED visit or hospitalisation. Perhaps most importantly, there are many medications that are known to cause harm in older adults (Fick et al. 2003). These medications while often appropriate in a critical care setting may lead to adverse medication events in older adult populations. Specifically long acting, hepatically cleared benzodiazepines; barbiturates; meperidine; haloperidol and other medications with narrow therapeutic index and a long half-life may impair CNS functionality unnecessarily prolonging sedation. In the case of meperidine, accumulation of a toxic metabolite may lead to CNS irritation and seizures. In some cases, the effects of haloperidol and other antipsychotic drugs may accumulate and take several weeks to fully metabolise in an acutely ill older adult with organ dysfunction.

Identifying Solutions: A Systems Approach

A deliberate systematic approach that evaluates the safety of the medication process using a variety of methods may prove to be the best solution to reducing medication errors. Proactively looking for system weaknesses utilising a multidisciplinary team through a medication pass audit approach will help in discovering system weaknesses that predispose our patients to medication misadventures before they happen. Other established strategies are the use of alert triggers, such as antidote administration, which do not rely on voluntary reporting from staff, as well as encouraging a non-punitive reporting process of 'near miss' errors through voluntary reporting. Once an error is identified through either a trigger alert or voluntary reporting, performing a root cause analysis to determine what contributing factors lead to the error is essential. It is also important to provide feedback to staff on system changes that were implemented as a result of identification of system vulnerabilities to reinforce the voluntary reporting process and encourage continued awareness. Enhanced educational efforts surrounding medication use should not be overlooked if patterns are identified in specific patient populations or medications, and should include a component of competency assessment for all levels of clinicians involved in the medication use process. Further, the use of a multidisciplinary team consisting of an intensivist, clinical pharmacist and nurse with lower patient ratios has been shown to reduce medication errors (Moyen et al. 2008 and Valentin et al. 2009).

One systems approach is the use of technology to standardise the medication ordering process. Computerised physician order entry (CPOE) is one system that has been shown to reduce prescriber errors (van Rosse et al. 2009). However, the use of CPOE does not appear to be enough to reduce all medication errors. In fact, a meta-analysis of CPOE systems on medication errors in pediatric intensive care units showed a significant reduction in prescribing errors but no effect on adverse medication events or mortality after implementation (van Rosse et al. 2009). It was also noted upon qualitative analysis that the implementation process of CPOE may be a determining factor to decide success or failure.

When adequately supported, adaptation of a CPOE system brings to the institution many improvements over handwritten clinician orders. Eliminating handwriting illegibility, abbreviation confusion and incomplete order writing, as well as providing improved formulary management, medication alerting capabilities, ability to implement standardised protocols for a specific disease state management, and improve time to administration of medication are all highly recognised benefits of CPOE systems. Facilities will quickly recognise that with the incorporation of such systems a reduction of these classically well know types of prescribing challenges will occur. However, it is important to not overlook that CPOE brings with it new types of medication errors facilitated by the use of this system that will need to be addressed (Koppel et al. 2005). A national study evaluating medication errors in emergency departments in the United States showed that up to 2.5% were caused by CPOE (Pham et al. 2008). Those most likely to occur as a result of CPOE were improper dose/quantity (28%), wrong patient (12%), and wrong dosage (8%). However, these errors were less likely to reach the patient than those not caused by CPOE.

Conclusion

Medication errors can be costly to the healthcare system and detrimental to the individual patient. Applying a systems approach that identifies and resolves institution specific risk areas leading to medication errors is an important step to improve patient safety and quality of care in the ICU and ED. Further, utilising a multidisciplinary team to identify high risk patients, and medications, are necessary measures to minimise the frequency and impact medication errors will have on patients, especially in high risk patient populations such as the critically ill.

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