Analysis of Medication Errors in Simulated Pediatric Resuscitation by Residents

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Introduction: The objective of our study was to estimate the incidence of prescribing medication errors specifically made by a trainee and identify factors associated with these errors during the simulated resuscitation of a critically ill child.

Methods: The results of the simulated resuscitation are described. We analyzed data from the simulated resuscitation for the occurrence of a prescribing medication error. We compared univariate analysis of each variable to medication error rate and performed a separate multiple logistic regression analysis on the significant univariate variables to assess the association between the selected variables.

Results: We reviewed 49 simulated resuscitations. The final medication error rate for the simulation was 26.5% (95% CI 13.7% - 39.3%). On univariate analysis, statistically significant findings for decreased prescribing medication error rates included senior residents in charge, presence of a pharmacist, sleeping greater than 8 hours prior to the simulation, and a visual analog scale score showing more confidence in caring for critically ill children. Multiple logistic regression analysis using the above significant variables showed only the presence of a pharmacist to remain significantly associated with decreased medication error, odds ratio of 0.09 (95% CI 0.01 - 0.64).

Conclusion: Our results indicate that the presence of a clinical pharmacist during the resuscitation of a critically ill child reduces the medication errors made by resident physician trainees. [West J Emerg Med. 2014;15(4):486–490.]

INTRODUCTION

Medication errors are a common cause of iatrogenic events in children. There are 3 types of medication errors: namely those in medication prescribing, dispensing, and administering.[1] In the emergency department (ED), up to 10% of medication errors result from prescribing errors.[2] Of these errors, medication error rates were found to be significantly associated with severely ill patients or when ordered by a trainee.[2] To our knowledge, there are no studies to date specifically describing the incidence or factors associated with medication errors during the resuscitation of a child by a resident trainee. At our institution, resident physicians are required to lead in the simulated resuscitation of a critically ill child, and efforts are made to simulate a real case scenario. The objective of our study was to estimate the incidence of prescribing medication errors specifically made by a trainee and identify factors associated with these errors during the simulated resuscitation of a critically ill child.

METHODS

We performed a prospective observational study using data obtained during an immersive simulated resuscitation of a critically ill child with first and third year pediatric residents from July 1, 2010 to November 30, 2011. Pediatric residents at our institution are required to lead in an immersive simulated resuscitation of a critically ill child during their pediatric emergency medicine rotation. The sessions occurred

in our simulation center using high technology manikins with capabilities of making physiologic responses to interventions.

An immersive simulation attempts to replicate real experiences with a team of participants that allow learners to address different aspects of resuscitation, including knowledge, decision-making, and teamwork. A pediatric working simulation group consisting of pediatric hospitalists, intensivists, emergency physicians, nurses, respiratory therapists, and pharmacists developed case scenarios based on actual patient encounters in the ED, inpatient unit, intensive care unit or during a transport of a critically ill child. Cases included a shaken infant with a traumatic head injury, a submersion injury requiring intubation, a teenager with septic shock, a child with status asthmaticus, and an automobile verse pedestrian accident with hypovolemic shock.

Each resident filled out a questionnaire prior to the simulation to determine background information related to the trainee's experience, level of training, and confidence in resuscitation of a critically ill child. Confidence was determined by having the resident place a line on a 100mm visual analog scale (VAS) with no confidence on the low end. Questionnaires also included details on the previous number of real case resuscitations and the amount of sleep the night prior to the simulation.

All the scenarios required medications to be prescribed during the resuscitation, but not all scenarios required the same medications. In an attempt to simulate real case scenarios in the ED, inpatient hospital unit or on transport, all cases included the participation of a nurse and respiratory therapists. At our institution, the presence of a clinical pharmacist is dependent on the time of day, so the participation of a clinical pharmacist was based on availability. This allowed us to evaluate the significance of having a pharmacist on overall medication error rates.

The supervising attending physician assigned cases randomly to each resident without knowledge by any of the participants. During the simulation, the supervising attending physician observed from the control room and made appropriate physiologic changes based on medications prescribed and interventions performed by the resident physician. Simulations were recorded and reviewed during the debriefing period for immediate feedback with all the participants. Videos were also stored on disc for a period of 2 weeks for review.

The study investigators reviewed the videotaped sessions regularly. Data collected from review of the videotapes included presence of a clinical pharmacist, cognitive aids used by the resident during the simulation, and details of the medications ordered. A medication was defined as prescribed when the resident verbally ordered the drug during the simulation. Each medication and dose prescribed by the resident physician was entered into the data collection form. Based on the stated weight, the dose per kilogram ordered was compared to the standard dosing for the final determination of a prescribing medication error. We combined data from the questionnaire and data collection form for analysis.

A final prescribing medication error was defined as a drug ordered that varied by at least 20% from the recommended dose, which also included not knowing the dose of the medication ordered. Error was also defined as drugs ordered by an incorrect route or an ordered drug that was not indicated for the patient's condition.[8] The Harriet Lane handbook (18th ed) and the PALS handbook (1st ed) were used as reference for standard recommended drug dosing.

Two of the study investigators reviewed the first 2 months of videotapes and completed the data collection forms together. The remaining videotapes and data collection forms were reviewed and completed by one study investigator. The second study investigator reviewed 10 percent of the data forms to determine inter rater reliability for a prescribing medication error.

We analyzed data using STATA 12.0 (Stata Corporation, College Station, Texas). Descriptive statistics of the data are reported. We compared univariate analysis of each variable to medication error rate, followed by a separate multiple logistic regression analysis on the significant univariate variables to assess the association between the selected variables. P value <0.05 was considered significant. We calculated a kappa statistic for inter rater reliability for the determination of a final prescribing medication error. In consultation with the institutional review committee of our institution, the study was exempt.

RESULTS

A total of 57 residents participated in the study; data or videotapes were incomplete or missing for 8. In the remaining 49 complete data sets, 26 (53.1%) of the subjects were interns. The questionnaire revealed that 33 (67.3%) of the residents had previous resuscitation experience. Sixteen (32.7%) had slept greater than 8 hours the night prior to the day of the simulation.

Review of the simulation revealed that a cognitive aid was used by 13 (26.5%) of the 49 participants. Cognitive aids included the use of a reference or code sheet, handheld device, small pocket book, and/or calculators. More interns (30.8%) compared to seniors (21.7%) used cognitive aids, but was not found to be statistically significant, p=0.47. Pharmacists were present during 23 (46.9%) of the simulated case scenarios. They were present during 14 (53.8%) of the 26 intern simulations and 9 (39.1%) of the 23 senior simulations, p=0.30.

There was a potential medication error rate of 40.8% (95% CI 26.6% - 55.1%) identified with the initial prescribed medication by the participant. Sixty-five percent were associated with error in dosing, 40% with an unknown dose, and 5% with an inappropriate medication ordered. Thirteen of the 20 (65%) initial prescribed medication errors were corrected prior to delivery to the manikin resulting in a final medication error rate of 26.5% (95% CI 13.7% - 39.3%). Pharmacists (71.4%) corrected majority of the prescribing

Table 1. Statistically significant findings for final decreased medication error rates.

Variable	Error with variable	Error without variable	p value
Level of training	13.0% (95% CI -1.8 – 27.5)	38.5% (95% CI 18.9 – 58.0)	0.04*
Sleeping > 8 hours	6.2% (95% CI - 6.3- 18.8)	36.3% (95% CI 19.2 – 53.5)	0.01*
Previous experience	24.2% (95% CI 9.0 – 39.5)	31.3% (95% CI 7.2 – 55.3)	0.60
Confidence	37.7 mm (95% CI 14.5 - 33.9)	24.2mm (95% CI 30.5 - 44.9)	0.04*
Pharmacist	13.0% (95% CI - 1.8 – 27.5)	38.5% (95% CI 18.9 – 58.0)	0.04*
Cognitive aid	23.1% (95% CI - 1.4 – 47.5)	27.8% (95% CI 12.6 – 43.0)	0.74

*significance <0.05

Table 2. Analysis showing protective effect of having a pharmacist present.

Variable	OR (95% CI)	p value
Pharmacist presence	0.09 (0.01 - 0.64)	0.02*
Year of resident	0.74 (0.07 - 7.66)	0.80
Hours slept	0.75 (0.45 - 1.26)	0.28
Visual analog scale	0.94 (0.88 - 1.01)	0.10

*significance <0.05
OR, odds ratio

errors, followed by a respiratory therapist (14.3%) and a nurse (14.3%). Pharmacists were never the source of a medication error, but there were 3 cases of a final medication error that occurred which were not caught during pharmacist presence. Our kappa statistic for the determination of prescribing medication error was 1.0, showing perfect agreement.

On univariate analysis, statistically significant findings for final decreased medication error rates included senior residents in charge, presence of a pharmacist, sleeping greater than 8 hours prior to the simulation, and a VAS score showing more confidence in caring for critically ill children (Table 1). Multiple logistic regression analysis using the above significant variables showed only pharmacist presence during resuscitation remained significantly associated with decreased medication error, odds ratio (OR) of 0.09 (95% CI 0.01 - 0.64) showing a protective effect (Table 2).

DISCUSSION

Medication error is a preventable cause of morbidity and mortality that has come to the forefront of medical practice. Variables associated with making medication errors are illness severity and the training level of the provider.[2] Prescribing errors with incorrect dosing are the most common type of errors made by physicians.[2,8-10] The ED has inherent features that place the pediatric patient at higher risk for experiencing adverse drug events. It is a high stress environment where acutely ill patients present to physicians who have no prior relationship and limited data on patient history. Critical decisions are made in an environment where multitasking and constant distractions are the norm. The pediatric ED has all the baseline distractions of an ED combined with required weight-based dose requirements of administered medications. The Joint Commission suggests efforts to reduce pediatric medication error include standard dose calculation forms for critically ill children, continued education and communication between staff, as well as access to a clinical pharmacist with expertise in pediatric care.[11]

Pharmacy presence in the ED has a significant impact on medication errors.[6,12-14] More medication errors are reported with the presence of a pharmacist in the ED and the recommendations given by pharmacist have a high acceptance rate.[15,16] One study completed in a rural ED showed a 66% difference in errors made before and after the implementation of an on-site clinical pharmacist.[17] A Veterans Administration study showed the cost avoidance realized of pharmacist presence in the ED to be $1.6 million per year based on interventions with a high probability to cause harm.[15] Consultative activities led to the highest number of error interceptions, 25% of which are described as serious or life threatening.[13] A recent study during trauma resuscitations found medication errors were 13 times more likely to occur when pharmacist were absent.[18] These gains have been demonstrated to be significant and lasting, leading to decreases in delayed medications and missed medications after the addition of a clinical pharmacist.[19]

Simulation has been used as a successful learning tool in many different hospital departments. Whether computer based, in situ or high fidelity, simulation shows demonstrable improvement within different disciplines related to patient care.[20] Nurses, physician and physician trainees, as well as pharmacist, all show improvement in self-reported confidence, technical skills, as well as reductions in medication errors after participation in such exercises.[21-23] These results hold true in the highly specialized setting of the pediatric ED. The incidence of medication errors in the pediatric ED has been shown to be as high as 10-15%.[24,25] A recent study shows such errors can be positively influenced after participating in simulated resuscitations.[20]

Our study chose to look at the prescribing medication errors made during high fidelity simulated pediatric emergency resuscitation. We showed a 25% difference in the

incidence of medication errors in the presence of a clinical pharmacist, and only the presence of pharmacist remained statistically significant after logistic regression analysis. These data are consistent with previous studies in the ED setting that demonstrate an improvement in medication errors with the addition of a pharmacist to the clinical team.

LIMITATIONS

Limitations of this study include a relatively small sample size and the lack of randomization. We obtained the study sample from a convenience sample of pediatric resident training physicians who are required to participate in a simulated resuscitation. As this was an observational study of simulated scenarios based on real-life cases, we were not able to randomize factors such as the presence of a clinical pharmacist. Additionally there were different resuscitation scenarios that required a variable number of medications that was not standardized. Although our results did not show a significant difference in the use of a cognitive aid, we do encourage the use of cognitive aids for patient safety best practice. Other factors may be significant but could not be detected in a sample of this size. The setting of this study was in a high fidelity simulation center, and though the manikins used mimicked physiologic changes seen in real patients they are not an exact substitute for the ED setting.

CONCLUSION

Our results show on univariate analysis that pharmacist presence, senior resident, > 8hrs of sleep and confidence are significantly associated with decreased medication error. Logistic regression showed pharmacist presence during resuscitation remained significantly associated with decreased medication error, OR of 0.09 showing a protective effect. Our study supports that having a pharmacist focus on medication dosing during resuscitations decreases medication errors made by trainees.

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