INTRODUCTION

Medication errors are a national concern that can compromise patient care and increase health-care costs. The American Society of Health-System Pharmacists (ASHP) defines omission errors as the failure to administer an ordered dose to a patient before the next scheduled dose. Wrong time errors are defined as the administration of medication outside a predefined time interval from its scheduled administration time. These errors can result in serious harm or even death.[1]

Pharmacists play a significant role in preventing medication errors. Pertaining to omission errors and wrong time errors, ASHP recommends that pharmacists ensure medications are delivered to the patient-care area in a timely fashion after the receipt of orders. In addition, pharmacists should review medications that are returned to the department to reveal system breakdowns. Because nurses are directly involved in patient-care activities including the administration of medications, they also play a large role in the prevention of medication errors. In order to prevent missing or delayed medications, communication is essential between nursing and pharmacy.[1]

Missing and delayed medications have been identified as a growing concern among providers and nurses at Carilion Roanoke Memorial Hospital, which warranted a closer investigation of the entire medication delivery process. Although missing and delayed medication doses are a common type of medication error, it is often difficult to determine the cause of these errors. Doses are often sent again without trying to locate the original dose in order to prevent delays. The purpose of this study was to determine underlying causes for

missing medications hospital-wide through prospective analysis, as well as identify reasons for medication delays specific to the pediatric population through retrospective analysis.

METHODS

The location for this study was Carilion Roanoke Memorial Hospital, a 763-bed community teaching hospital in Roanoke, Virginia. Carilion Children's Hospital is located within Carilion Roanoke Memorial Hospital, and includes a general pediatric unit and a pediatric intensive care unit (PICU), consisting of a total of 32 beds. The Carilion Clinic Institutional Review Board determined the study did not meet the regulatory definition of human subjects research and was deemed to be a quality assurance/quality improvement activity.

Prospectively, delayed or missing medications data was collected for 6 weeks (June 7, 2015 to July 12, 2015) at Carilion Roanoke Memorial Hospital. A direct observational study was conducted for a random selection of electronic message notifications or phone calls from nurses regarding delayed or missing medication doses during the hours of 0700-1900. Messages or calls received outside of these hours were excluded. A missing medication request prompted a search for the medication in the pharmacy and on the nursing unit to discover the location or cause. Each missing or delayed medication request was recorded on a standardized data collection form, and the outcome for each search was documented as resolved or not resolved. For each resolved outcome, the exact location or cause of the missing medication was noted. Additional data collected included dispense location, medication type, and order type.

The retrospective portion of this study was conducted by electronic medical record review of orders within the pediatric patient care units of Carilion Children's Hospital. A total of

300 pediatric medication orders were randomly selected from the orders of 10 commonly prescribed medications (ordered between December 1, 2014 and May 31, 2015). The medications included in the study are a sampling of the top medications ordered that are dispensed from either the main inpatient pharmacy, inpatient admixture center, or the automatic dispensing system (ADS). The following medications dispensed from the main inpatient pharmacy were included: levetiracetam oral solution, ranitidine oral syringe, sucralfate oral suspension, and mupirocin ointment. The following medications dispensed from the inpatient admixture center were included: piperacillin-tazobactam IV, levetiracetam IV, metronidazole IV, ampicillin injection, and vancomycin IV. The following medication dispensed from the automatic dispensing unit on the floor was included: ketorolac vial. The orders were analyzed to determine the median time intervals between order entry, order verification by pharmacist, scheduled due time, and actual administration time. Variables collected from the electronic medical record included: medication, order priority, order entry time, verification time, location of dispense, scheduled due time, administration time, and messages between nursing and pharmacy staff. Descriptive statistics were used to identify trends in the medication dispensing process.

RESULTS

For the prospective analysis, a total of 140 missing medication requests were documented over 6 weeks. Of the 140 requests, 93 (66%) medications were tracked to determine the actual location. A total of 47 (34%) requests for medications were unable to be tracked when the message or call was received due to lack of time or personnel. A total of 72 of the 93 missing medications (77%) were resolved after a search for the medication was conducted. Twenty-six

(36%) medications were found in the pharmacy, 23 (32%) were found on the nursing unit in various locations, and 23 (32%) were determined to be due to a failure in technology (i.e., automatic dispensing system stocks-outs or failure of the label to print). A breakdown of the underlying causes of the missing medications is provided in Figure 1 (see Appendix). Of the 93 medications that were tracked, 32% still had an unknown underlying cause, 26% were waiting in the pharmacy for delivery, 15% were due to automatic dispensing unit stock-outs, 15% were found in the incorrect storage location, 10% were due to a failure of the label to print, 1% were found in the automatic dispensing unit, and 1% had not been dispensed yet. Examples of medications found in incorrect storage locations included the wrong patient's bin, the wrong unit, the wrong tube station, and a nurse's pocket.

For the retrospective study, a total of 300 pediatric electronic medical record orders were analyzed. Of the 300 orders, 165 were cart fill, 34 were first doses, 5 were "STAT", and 96 were classified as "other." The medication orders classified as "other" were medications that were not first doses and had not been converted to cart fill yet. The median time between order entry and verification by a pharmacist was 7 minutes for routine orders and 3 minutes for STAT orders. For first doses (N=34), the median time between order verification by a pharmacist and scheduled due time was 47 minutes. The median time between the scheduled due time and actual administration time was 27 minutes after the scheduled due time. For maintenance doses (N=165), the median time between scheduled due time and actual administration time was 11 minutes after the due time. A side-to-side comparison of the median time between due time and administration by order type is displayed in Figure 2 (see Appendix). Figure 3 displays the median time between due time and administration by dispense location. The median times

between due time and administration were similar across all three dispense locations (ADS, inpatient admixture center, and main inpatient pharmacy).

DISCUSSION & CONCLUSION

In the prospective analysis, a similar number of missing medications were discovered in the pharmacy and on the nursing unit. The underlying causes of missing and delayed medications were contributed to a number of reasons. Of those found in the pharmacy, the majority of medications were waiting in a bin to be delivered by a technician. The medications found in the nursing unit were discovered in a variety of locations. Medications being delivered or tubed to the wrong nursing unit could have been caused by oversight or a breakdown in communication. In addition, there were a few cases of patients being transferred to a different patient care unit without their medications being transferred with them. Another common cause for missing and delayed medications was a result of a failure in technology. A limitation to this study is that a new version of the ADS was being rolled out during the time the data was being collected. As a result, there were several issues involving ADS stock-outs and other technology failures that may have contributed to many requests for missing and delayed medications.

In the retrospective study, verification times were within the hospital verification goals of 60 minutes for routine orders and 15 minutes for STAT orders. When analyzing the time between due time and administration, the dispense location did not seem to have an impact on the administration time. Areas of improvement were identified in both the pharmacy medication distribution and nursing medication administration processes, including increased efficiency and accountability in the technician delivery of medications. Future directions include the need for

increased collaboration between nursing and pharmacy staff to reduce the number of missing medication requests. In the short-term, a committee composed of both pharmacy and nursing staff could be established to further address these issues. Long-term solutions to missing medication requests could include the investment in a medication tracking system.

ACKNOWLEDGMENTS

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REFERENCES

1. American Society of Health-System Pharmacists. ASHP guidelines on preventing medication errors in hospitals. *Am J Hosp Pharm*. 1993; 50:305-314.

APPENDIX

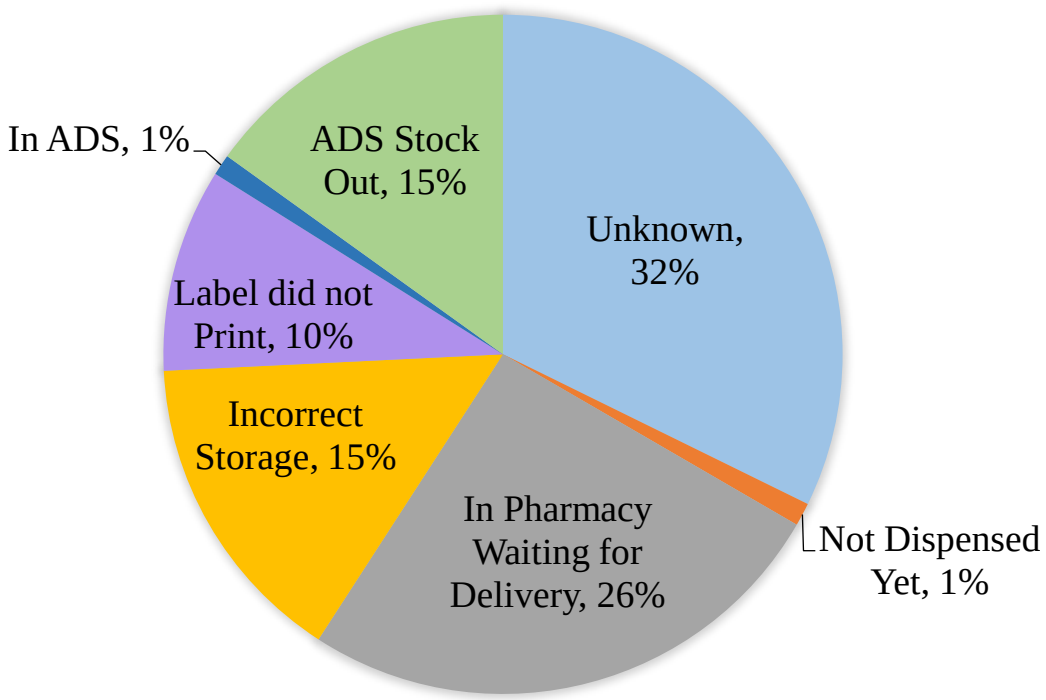

Figure 1. Breakdown of the underlying cause of missing or delayed medications (N=93).

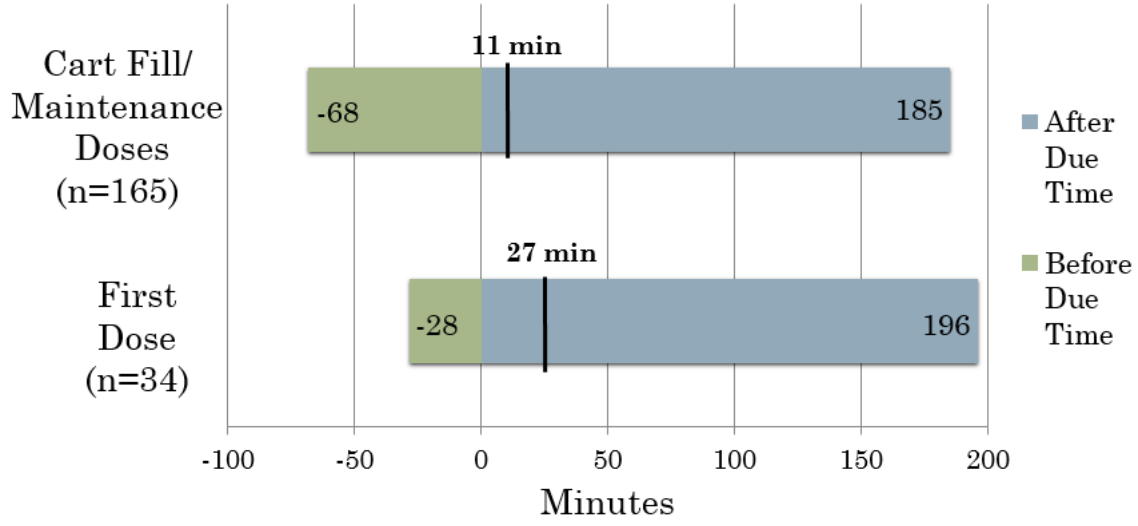

Figure 2. Median time between due time and administration by order type (N=199). "0" Minutes represents the due time. The bar represents the range of administration time, with the earliest time of administration in the green, and the latest time of administration in the blue. For example, in this chart, the earliest first dose medication was given 28 minutes before the due time, and the latest first dose medication was given 196 minutes after the due time. The median time of administration for first doses was 27 minutes after the due time.

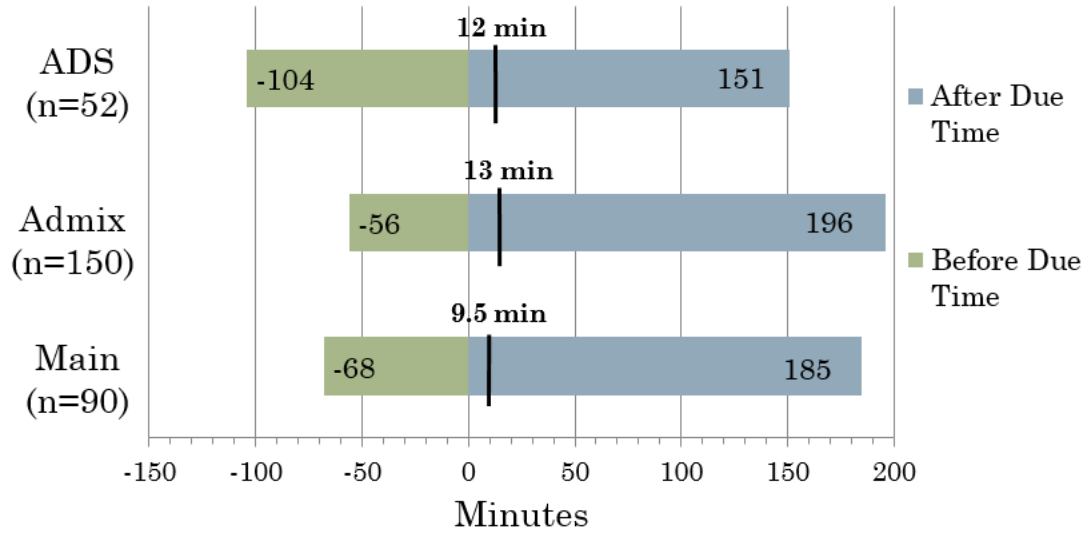

Figure 3. Median time between due time and administration by dispense location (N=292). "0" Minutes represents the due time. The bar represents the range of administration time, with the earliest time of administration in the green, and the latest time of administration in the blue. For example, in this chart, the earliest ADS medication was given 104 minutes before the due time, and the latest ADS medication was given 151 minutes after the due time. The median time of administration for ADS medications was 12 minutes after the due time.