JPPT | Single-Center, Prospective Observational Study

Effect of a Pharmacist Admission Medication Reconciliation Service at a Children's Hospital

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OBJECTIVE To evaluate the clinical effect and estimate cost avoidance attributed to a pharmacist-led admission medication reconciliation service at a children's hospital.

METHODS This was a prospective observational cohort study that measured pharmacist interventions for pediatric patients over a 90-day period. Pharmacists logged all interventions identified during medication reconciliation in real time. Patient demographic data were collected retrospectively. Cost avoidance from prevented adverse drug events (ADEs) was estimated based on previously published literature.

RESULTS Pharmacists completed 283 admission medication reconciliations during the study period. Of those, 69% of medication reconciliations required intervention. Interventions affected care during the hospital admission in 21.9% of patients and 8 medication reconciliations resulted in prevention of a major ADE. This pharmacist-led service resulted in an estimated cost avoidance of $46,746.65 in the 3-month period.

CONCLUSIONS Implementation of a pharmacist-led admission medication reconciliation service for pediatric patients improved medication safety and resulted in significant cost avoidance, which justifies investment in these pharmacist resources.

ABBREVIATIONS ADE, adverse drug event; ED, emergency department; EMR, electronic medical record; ICU, intensive care unit

KEYWORDS medication; medication reconciliation; pediatrics; pharmacist

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Background

Adverse drug events (ADEs) are a significant concern in pediatric patients, with 3 to 37% of hospitalized children experiencing an error in medication prescribing.[1] Admission medication reconciliation has been recognized as a major clinical intervention to reduce unintended medication discrepancies in the inpatient setting and has been a National Patient Safety Goal from The Joint Commission since 2005.[2,3] A systematic review by Tam et al[4] estimated that 67% of pediatric patients experience an error at the time of admission medication history and these authors concluded that pharmacist participation in the medication history process could reduce the frequency of errors. The clinical benefit of pharmacist involvement in medication reconciliation is widely confirmed in a variety of studies in the adult population.[5–8] Two large systematic reviews, published by Mekonnen et al,[5,6] evaluated the effect of pharmacist interventions on medication discrepancies (19 studies; n = 15,525) and on clinical outcomes at hospital transitions (17 studies; n = 21,342) in the adult population. These studies demonstrated that pharmacy-led medication reconciliation intervention, even at a single transition of care, significantly reduced medication discrepancies by 66% (RR 0.34).[6] Furthermore, the authors demonstrated that pharmacist-led medication reconciliation programs resulted in a reduction in ADE-related hospital revisits, emergency department (ED) visits, and hospital readmissions.[5]

The effect of pharmacist interventions on cost savings is important for allocation of resources within a hospital system. Additional literature has attempted to evaluate the associated cost-savings with medication error avoidance through pharmacist interventions. A comprehensive review of cost avoidance data from pharmacist interventions within inpatient intensive care units (ICUs) and ED visits was published by Hammond et al.[9] While this review was not focused on pediatric patients, the data used to estimate cost avoidance from major and minor ADEs were pulled from general studies of hospitalized patients. The authors define a major ADE prevention as "actions that could prevent temporary or permanent patient harm" and minor ADE prevention as "other interventions that may lead to downstream prevention of major ADEs."[9] These authors estimated that cost avoidance of major and minor ADEs prevented during medication reconciliation was valued at $3277.25 and $380.16 respectively in 2018 dollars.[9]

The effect of pharmacist medication reconciliation specifically in the pediatric setting remains limited. In 2009, Coffey et al[10,11] described the effect of pharmacist completed medication reconciliation at a tertiary care children's hospital in Toronto, Canada. At least 1 discrepancy was found in 76% of patients; however, only 22% of these discrepancies were classified as unintentional.[10] Of the unintentional errors, 23% were classified as having moderate and 6% were classified as having severe potential to cause discomfort or clinical deterioration.[10] A similar study completed by Abu Farha et al[12] from Jordan noted medication discrepancies were found by pharmacists in 13% of patients admitted, with the majority of errors noted to be minor in nature. In 2020, Rungvivatjarus et al[13] published the results of a quality improvement project at a pediatric hospital in San Diego, CA, which included pharmacist involvement, however not all patients received pharmacist intervention. Pharmacists were included within a larger multidisciplinary group whose medication reconciliation program intervention increased overall rates of medication reconciliation completion and decreased omission errors at admission.[13] To date, no studies directly evaluating the effect of pharmacist-led admission medication reconciliation in the United States have been published in the pediatric population.

The current study aims to characterize pharmacist interventions at the time of admission medication reconciliation for pediatric patients admitted to an academic children's tertiary care medical center in Chicago, IL. Intervention data will be used to estimate cost avoidance of this service through assessment of harm and avoidance of both major and minor ADEs.

Methods

Design. This was a prospective observational study, conducted over a 90-day period at a single academic, tertiary care children's hospital (May 2019 through July 2019). Pediatric patients (< 18 years of age) admitted to the pediatric ICU or pediatric general medicine unit during the study period were included. Those 18 years old or older and admitted to units other than these pediatric patient care units were excluded. The outcomes assessed were time to completion of pharmacist admission medication reconciliation, the number of medication-related pharmacist interventions, and the types of medication-related pharmacist interventions. Pharmacist interventions were classified into the following categories: missing medication, missing information, incorrect dose, medication discontinued, and/or medication adherence concern. In addition, an assessment of patient outcomes related to the intervention was performed. Interventions were assessed to determine if they affected care during each hospital admission (defined as requiring change to the patient's current active care plan or requiring immediate changes to a medication ordered during the admission) and if a high-risk medication was involved in the intervention (antiepileptic, immunomodulator, cardiovascular, anticoagulant, and/or antidiabetic agents). Lastly, an assessment of if the intervention may have prevented harm or death was made by the intervening pharmacist. Harm was defined as intercepting an error which, in the pharmacist's clinical judgement, prevented the patient from experiencing significant drug toxicity or therapeutic failure possibly resulting in a sentinel event (e.g., missing antiepileptic, insulin overdose, 10-fold dosing error). Cost avoidance was estimated using previously published literature and assessment of the prevention of major and minor ADEs.[9] The cost avoidance associated with prevention of a major ADE was $3277.25 and $380.16 for prevention of a minor ADE, calculated in 2018 dollars without adjustment for inflation.

Description of Pharmacist Service. The pharmacist-led admission medication reconciliation service for pediatric patients was implemented at Rush University Children's Hospital in July 2018. Rush University Children's Hospital is a 110-bed children's hospital within a tertiary care academic medical center in Chicago, IL. Pharmaceutical care is provided to children through a combination of services completed by pediatric clinical pharmacist specialists with pediatric board certification and specialty residency training and pediatric clinical operational pharmacists. Pediatric clinical operational pharmacists have decentralized time and participate in pediatric admission medication reconciliation. Prior to initiation of the pharmacist-led service, admission medication reconciliation was performed at the time of admission solely by medical residents caring for the patients. Following initiation of the pharmacist-led service, a pharmacist completed an additional medication reconciliation to augment the existing workflow. Providers were educated about the new service and informed that the pharmacist service is intended to augment not replace the existing workflow. Providers were still expected to complete medication reconciliation for all patients at the time of admission.

Pharmacist completed medication histories were performed through patient and caregiver interviews, contact of outpatient home pharmacies to review refill histories, and review of electronic medical records (EMRs) to obtain an accurate prior to admission medication list. The medication history could be taken directly by the pharmacist performing the medication reconciliation, or by an advanced practice pharmacy experience student or pharmacy intern who documented their patient or caregiver interview within pharmacy specific notation in the EMR. If the medication history was completed by a pharmacy student or pharmacy intern, a formal review with completion of EMR documentation was finalized by a specialist or operational clinical pharmacist. Contacting the patient's outpatient home pharmacy was performed for select patient encounters at the discretion of the clinical

Table 1. Patient Demographics

Baseline Demographics	Value (N = 283)
Age, mean ± SD, yr	7.6 ± 6
Race, n (%)	
Caucasian	101 (35.7)
African American	100 (35.3)
Other	82 (29)
Hispanic, n (%)	78 (27.6)
Admission unit, n (%)	
Pediatric intensive care unit (PICU)	71 (25)
General pediatrics	212 (75)
Length of hospital stay, mean ± SD, days	3.2 ± 3.5
Number of medications at admission, mean ± SD	4.3 ± 4.6
Primary diagnosis, n (%)	
Cardiology	7 (2.5)
Ear, nose, throat (ENT)	19 (7)
Endocrine	4 (1)
Gastrointestinal	24 (8.5)
Hematology or oncology	15 (5)
Infectious disease	17 (6)
Neurology	71 (25)
Pulmonary	42 (15)
Renal	11 (4)
Other	73 (26)

Table 2. Pharmacist Interventions

Metric	Result (N = 283)
Time to medication reconciliation, mean ± SD, hr	23.5 ± 25.3
Pharmacist intervention required, n (%)	196 (69)
Pharmacist interventions, n (%)*	
Missing medication	59 (20.8)
Missing information	79 (27.9)
Incorrect dose	62 (21.9)
Medication discontinued	79 (27.9)
Adherence concern	25 (8.8)
Intervention affected care during admission, n (%)	62 (21.9)
High-risk medication involved, n (%)*	
Antiepileptic	40 (14.1)
Immunomodulator	2 (0.7)
Cardiovascular agent	7 (2.5)
Anticoagulant	0 (0)
Insulin	4 (1.4)
Intervention may have prevented harm or death, n (%)	8 (2.8)

* May have included multiple interventions or medications for each patient.

pharmacist completing the medication reconciliation. After the medication history was obtained, the clinical pharmacist updated the prior to admission medication list within the EMR. This updated medication list was then compared with medications ordered during the current hospital admission, and medical providers were contacted if discrepancies requiring intervention were identified.

Data Collection and Analysis. Data were prospectively collected by all pediatric pharmacists performing admission medication reconciliation during the study period. At the time of admission medication reconciliation, pharmacists collected a patient identifier, cataloged all interventions performed, and made a risk assessment of the interventions performed. The study team used the patient identifier to then retrospectively collect patient demographic data. Data were stored and analyzed using REDCap online software (Vanderbilt University, Nashville, TN). Descriptive statistics were used.

Results

Pharmacists completed admission medication reconciliation on 283 patients during the study period, representing 73% of total admissions to the 2 pediatric units. Patients included were on average 7.6 years old (SD 6), were admitted to the hospital for 3.2 days (SD 3.5 days), and were on 4.3 medications preadmission. The majority of patients were admitted to the general pediatrics unit (75%) and the most common admitting diagnoses were neurology (25%), pulmonology (15%), and other (26%). Patient demographics are outlined in Table 1. The time to pharmacist completed medication reconciliation was on average 23.5 hours after admission (SD 25.3 hours).

Pharmacist documented medication interventions in 196 patients (69%) with missing information and medication discontinuation being the most common intervention type (Table 2). Missing medications or incorrect doses were noted in 20.8% and 21.9% of interventions, respectively. Antiepileptic medications were the most common high-risk medication involved in medication discrepancies. Pharmacist interventions affected patient care during the admission in 62 patients (21.9%), and pharmacists made 8 (2.8%) interventions that may have prevented harm or death. The 3-month cost avoidance with implementation of a pharmacist-led medication reconciliation was estimated at $46.746.65 ($26,218 for prevention of 8 major ADEs plus $20,528.65 for prevention of 54 minor ADEs) (Table 3). This correlated to an approximate annual cost-savings of $186,986.60.

Discussion

This study is the first to quantify the effect of a pharmacist-led admission medication reconciliation

Table 3. Estimated Cost Savings

Cost Estimates	Cost* Avoidance Per ADE	Total Cost Avoidance
Major ADE prevented, n = 8	3277.25	26,218.00
Minor ADE prevented, n = 54	380.16	20,528.65
3-mo projected cost avoidance	—†	46,746.65
Annualized projected cost avoidance	—	186,986.60

ADE, adverse drug event

* United States dollars (USD); † indicates not applicable.

service in pediatric patients in the United States. Similar to previous adult literature, we demonstrated a high rate of unintentional medication reconciliation errors. Pharmacists performed at least 1 intervention in 69% of pediatric patients interviewed, which is comparable with the estimate of 67% generated by Tam et al.[4] Abu Farha et al[12] performed a similar study in pediatric patients and found a much lower event rate of 13% of medication records containing at least 1 unintentional discrepancy. Their lower overall event rate may have been partly reflective of the lower number of preadmission medications 2.6 (SD 1.7) seen in their pediatric population when compared with that seen in the current study 4.3 (SD 4.6). In addition, differences in study patient populations and possibly patient complexity, as well as the fact that their study was completed outside of the United States, may account for the differences in error rates identified. Other differences in intervention rates between studies may be secondary to differences in study intervention classifications and interindividual differences in pharmacist completing the admission medication reconciliation and making harm assessments.

Compared with the Coffey et al[10] study, we found a lower rate of significant harm associated interventions (6% vs 2.8%). This lower rate may be due to the subjective nature of classifying risk and the fact that multiple clinical pharmacists were involved in the medication reconciliation process. In addition, some errors may have already been intervened on by a pharmacist during interdisciplinary rounds or at time of order verification prior to when the official admission medication reconciliation was performed. At this institution, clinical pharmacists are not routinely available through all shifts to perform medication reconciliation and therefore a delay from time of admission until medication reconciliation is completed may occur. It is possible that other pharmacy-based interventions may have been made during this timeframe and that were not captured in data collection. It should also be noted that interventions in this study were classified by the intervening pharmacist and were not reviewed or confirmed by study investigators, which could limit objectivity of results.

Compared with previous studies, the current study results demonstrate that clinically and economically significant pharmacy interventions can be completed fairly quickly following hospital admission. We presume that the clinical training of pharmacists assisted in an efficient clinical initiative. Literature evaluating cost-avoidance with pharmacist intervention is a growing area of interest to help quantify the benefit of pharmacy-based services. The cost-avoidance calculated in this study is based on a previously published review focusing on ICU and ED pharmacist interventions.[9] This is the most recent review with cost estimates relevant to this study published in the literature. It is important to note that these types of cost estimates are based on variable quality of evidence and may overestimate actual cost savings associated with these interventions.[14,15] Furthermore, this review focused on adult literature as supportive evidence for their intervention-based cost-savings analysis, which may not be applicable to the pediatric population in this study. Further pediatric-specific pharmacoeconomic data are needed to fully and accurately assess the cost-avoidance of similar pharmacist-based services in the pediatric population.

Conclusion

Implementation of a pharmacist-led admission medication reconciliation service for pediatric patients improved medication safety and resulted in significant cost avoidance, which justifies investment in these pharmacist resources.

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Ethical Approval and Informed Consent. The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national guidelines on human experimentation and have been approved by the Institutional Review Board at Rush University Medical Center, Chicago, IL. Informed consent was not required.

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