Influence of a Systems-Based Approach to Prescribing Errors in a Pediatric Resident Clinic

Michelle Condren, PharmD; Brooke L. Honey, PharmD; Sandra M. Carter, MLA, MPH; Nelson Ngo, BS; Jeremy Landsaw, BS; Cheryl Bryant, MD; Stephen Gillaspy, PhD

From the Department of Pharmacy, Clinical and Administrative Sciences—Tulsa, University of Oklahoma College of Pharmacy and Department of Pediatrics, University of Oklahoma School of Community Medicine, Tulsa, Okla (Dr Condren and Dr Honey); University of Oklahoma College of Pharmacy, Oklahoma City, Okla (Ms Carter, Mr Ngo, and Mr Landsaw); and Department of Pediatrics, Section of General and Community Pediatrics, University of Oklahoma College of Medicine, Oklahoma City, Okla (Dr Bryant and Dr Gillaspy)
The authors declare that they have no conflict of interest.
Address correspondence to Michelle Condren, PharmD, Department of Pharmacy, Clinical and Administrative Sciences—Tulsa, University of Oklahoma College of Pharmacy, Department of Pediatrics, University of Oklahoma School of Community Medicine, 4502 East 41st St, Suite 2H20, Tulsa, OK 74135 (e-mail: michelle-condren@ouhsc.edu).
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ABSTRACT

OBJECTIVE: To measure the difference in prescribing error rates between 2 clinics, 1 with a system in place to reduce errors and 1 with no such system; to determine variables that affect the likelihood of prescription errors.

METHODS: This was a retrospective study at 2 university-based general pediatric clinics utilizing the same electronic medical record (EMR) system. Clinic 1 employed pharmacists who provided daily prescription review, provider feedback and education, and EMR customization to decrease errors. Clinic 2 had no systems in place for reducing prescribing errors. Prescriptions written by resident physicians over 2 months were identified and reviewed.

RESULTS: A total of 1361 prescriptions were reviewed, 40.7% from clinic 1 and 59.3% from clinic 2. Errors were found in 201 prescriptions (14.8%). Clinics 1 and 2 had error rates of 11% and 17.5%, respectively ($P = .0012$). The odds of a prescription error at clinic 2 were 1.7 times the odds of a prescription error at clinic 1. Logistic regression identified clinic, nonpediatric resident, liquid dose forms, and younger patient age as significant predictors of prescription errors. Half of the errors could have been prevented with consistent use of a custom medication list within the EMR.

CONCLUSIONS: We found 37% fewer prescribing errors in a clinic with systems in place for prescribing error detection and prevention. Pediatric clinics should explore systematic procedures for identifying, resolving, and providing education about prescribing errors to reduce patient risk.

KEYWORDS: electronic medical record; medication errors; pediatrics; prescribing errors

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WHAT'S NEW

Potential benefits of prescription monitoring, ongoing prescriber education, and electronic health record customization on prescribing errors in outpatient pediatrics are explored. Factors predicting the likelihood of prescribing errors are identified.

APPROXIMATELY 1.3 MILLION injuries annually in the United States result from medication errors.[1] These events can be caused by many factors, including errors in prescribing, dispensing, compounding, dosing, communication, packaging, and adherence.[2] Prescribing errors, a type of medication error, are a leading cause of potentially preventable injuries to patients.[3,4]

Although almost half of serious medication errors can be attributed to clinicians having insufficient information about the patient and the drug, other factors, including calculation errors, transcription errors, and illegibility of handwritten orders, have been cited as contributing to errors.[5] Children are expected to experience higher prescribing error rates than adults as a result of inconsistent dosing recommendations related to age and weight, difficulties with liquid medication regimens, and the necessity of additional calculations.[6,7]

Family medicine clinic studies have reported error rates ranging from 14% to 19%; one study of an adult only primary care practice reported errors in 7.6% of prescriptions.[8–10] An outpatient study of children observed a 15% rate of dosing errors for select medications, while another pediatric outpatient study assessing all new prescriptions reported a 9.7% error rate.[11,12]

Because of the ease of administration and the ability to provide individualized dosing, oral liquids are commonly prescribed for children. However, they are particularly susceptible to prescribing and administration errors. For example, acetaminophen, like many liquid medications, is produced in multiple oral and intravenous concentrations. Concentrated acetaminophen for infants was reformulated by the US Food and Drug Administration in 2011 to a single concentration that matches the marketed formulation and helps decrease confusion.[13] Furthermore, electronic medical records (EMR) may not delineate which solutions are oral and which are intravenous. When this is

added to the potential mathematical errors, higher medication error rates potentially result.

The majority of pediatric medical care occurs in the outpatient setting, where prescribing errors are a common occurrence and where the outcomes of intervention strategies to prevent prescribing errors in the ambulatory pediatric population have not been well documented. EMR implementation has been demonstrated to facilitate the identification of error sources in pediatrics, allowing targeted education and training efforts aimed at decreasing error rates.[12] Medication errors are also potentially decreased through the integration of an e-prescribing system into the EMR. One trial studying inpatient computerized order entry by physicians found a 55% medication-related error reduction.[5] Further study evaluating ongoing upgrades to the application with greater clinical decision support showed an 83% reduction in the overall medication error rate.[5] Studies have documented the role of pharmacists in intercepting prescribing errors in the inpatient pediatric setting, but to our knowledge, no such studies have been replicated at the community pharmacy level, where outpatient prescriptions receive their final review.[14,15] Here we compare prescribing error frequencies of 2 pediatric clinics, 1 with a systems-based approach to prescribing error reduction and 1 without such interventions.

METHODS

This was a retrospective comparative study at 2 general pediatric clinic systems affiliated with resident training programs. The clinics were based in different cities but used the same EMR, Centricity EMR 9.5. The 2 systems were managed and run independently. There was no crossover between the clinics, including clinic staff, providers, and medical residents. Clinic 1 began using the EMR in 2006 and employed pharmacists that led initiatives to decrease prescribing errors. Clinic 2 also began using the EMR in 2006 but did not have a system to reduce prescribing errors. Multiple initiatives were in place to reduce errors in clinic 1. First was daily prescription review by a pharmacist utilizing a report generated the day after prescriptions were written. When errors were discovered, prescribers were notified to resolve errors and to provide education and feedback. Depending on error severity, communication between the pharmacist and the provider occurred through the EMR, by telephone, or in person. The pharmacist was typically involved in resolving the error through communication with the family and/or pharmacy. Information about errors was used to recommend updates to the EMR custom medication selection list to limit choices and prepopulate fields with instructions, quantities, and dosing decision support when appropriate. The EMR system did not reliably differentiate between solutions that were oral versus intravenous. The system was not designed to allow for changes in this functionality, but education addressing the issue was provided. Additionally, users were encouraged to use the custom medication list created by the pharmacists in order to avoid unintentionally choosing an intravenous dose form. In order to avoid calculation errors related to using pounds rather than kilograms, the EMR was modified to display weight in kilograms only and to alert the provider if a weight changed by more than 2 standard deviations from the previous visit, as would be expected if the weight was mistakenly entered in pounds. By analyzing the cause of errors, education was provided on best practices in the use of the EMR to avoid errors.

All prescriptions written in the general pediatric clinics between October 1 and November 31, 2012, were examined, and prescriptions written by resident physicians were identified. Prescriptions were reviewed through a deidentified report of all prescriptions written. Data collection included: location of clinic, resident training program (ie, pediatrics, family medicine, internal medicine-pediatrics), patient age, medication, and dose form. Each prescription was analyzed for presence of an error, type of error (ie, inadequate or incomplete prescription, dosing outside of the recommended range, drug selection error, and errors with administration method), medication classification, and error significance.

A dosing error was indicated if a medication dose deviated by more than 10% above or below the indicated dose range on the basis of the Pediatric Dosage Handbook or primary literature support.[12,16] Errors were reviewed by pediatric-trained pharmacists, with 2 people reviewing independently and a third person adjudicating any differences. Error severity was classified as potentially no harm, potentially minor harm, potentially significant, potentially serious, potentially life-threatening, and potentially fatal. Error severity classification was adapted from Morimoto et al.[17] Potential severities were added as a result of the possibility, but not the certainty, of the error severities listed. “Potentially minor” and “potentially no harm” were included to encompass less harmful errors. An error was labeled as preventable if use of the EMR custom medication list created for clinic 1 would have prevented the error from occurring.

The primary goal of this study was to measure the difference in prescribing error rates between 2 clinics, 1 with a system in place to reduce errors and 1 with no such system. A sample size calculation determined that 721 prescriptions would need to be reviewed to detect a 4% difference in prescribing error rates between the 2 clinics with an α of 0.05 and 80% power. An expected error rate of 10% was derived from baseline data from clinic 1 and the 4% difference in error rates was derived from the decrease seen after implementation of error reduction initiatives in clinic 1. Descriptive statistics were produced collectively and by clinic in order to quantify the study groups on the basis of patient, physician, medication, and error data. For primary analysis purposes, residents in family medicine and internal medicine/pediatrics training programs were categorized as nonpediatric residents. Age was categorized during the preliminary analysis into 4 categories of roughly equal range in order to better describe and investigate the potential association between age and errors. Univariate analyses were prepared for individual variables, and bivariate analyses were performed on pairs of variables using