A Quality Improvement Initiative: Improving the Frequency of Inpatient Electronic Prescribing

Jennifer Fuchs, MD, Huay-ying Lo, MD, Andrew Peterman, BS, Elizabeth Camp, PhD, Lindsay Chase, MD

**OBJECTIVE:** To improve the frequency of electronic prescribing (e-prescribing) of discharge prescriptions at a children’s hospital via a bundle of quality improvement interventions.

**METHODS:** Surveys and focus groups were conducted with patient families and pediatric residents to identify barriers and propose solutions to e-prescribing. These data were used to generate a series of interventions, including the following: (1) provider education; (2) changes in patient registration workflow; and (3) electronic health record changes to improve the frequency of e-prescribing on the pediatric hospital medicine (PHM) service. The primary outcome measure was the e-prescribing frequency, with a balance measure of e-prescribing errors.

**RESULTS:** From July 2014 through June 2015, e-prescribing frequency on the PHM service improved from a median of 7.4% to 48.9% \((P < .001)\) and was sustained for an additional 6 months (July 2015–December 2015), surpassing meaningful use targets with associated *US News and World Report* hospital ranking points. The frequency of PHM prescription errors remained unchanged, and in comparison, the resident outpatient clinic revealed no statistically significant change in e-prescribing frequency during this time period.

**CONCLUSIONS:** Engaging front-line providers in hospital-wide initiatives and quality improvement interventions can directly affect hospital metrics in programs such as meaningful use and *US News and World Report*, as shown through successful improvement in PHM e-prescribing frequency. Future studies are necessary to determine whether increased e-prescribing frequency affects patient outcomes and compliance.

Electronic prescribing (e-prescribing) was defined in 2008 by the Centers for Medicare & Medicaid Services as a system providing prescribers with the ability to “electronically send an accurate, error-free and understandable prescription directly to a pharmacy from the point-of-care.” E-prescribing reduces the risk of prescribing errors by >50% and leads to increased efficiency and improved patient safety, although its use is still limited in many hospitals. The most frequent medication errors occur at the point of prescribing, and even printing prescriptions from an electronic health record (EHR) system can lead to errors because pharmacists must then manually enter the information into the pharmacy system. E-prescribing improves communication with pharmacies, granting access to patient information such as allergies or previously failed

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antibiotic regimens, and minimizing the need to clarify illegible prescriptions.2,9 It also reduces pharmacy wait time and improves patient satisfaction, a key component in quality of care and pay-for-performance metrics.10

Given the potential benefits, there are incentive programs such as meaningful use (MU) that encourage e-prescribing. In fact, e-prescribing was changed from an optional menu to a required core objective measure for eligible hospitals in the most recent MU rules.11 Under MU, providers can either attest as individuals (eligible providers) or may be viewed collectively as part of an institution (eligible hospital). Many front-line hospital providers such as residents and hospitalists are not eligible providers, either because they are trainees or because they do not meet eligibility requirements based on the nature of their practice; however, these providers have direct impact on the eligible hospital MU metrics. Historically at our institution, MU initiatives have focused on outpatient eligible providers. Recently, the US News and World Report began including MU status in their hospital rankings, with hospitals receiving up to 2 points based on MU certification.12 With this change, there has been increased focus on inpatient hospital MU metrics, such as e-prescribing, but often without the corresponding involvement of the frontline providers that directly affect these metrics. In addition, many barriers have hindered the rapid adoption of e-prescribing systems, most notably the complexity of integrated electronic systems and physician resistance to change.13,14 However, few studies have assessed improving the frequency of discharge e-prescribing in the inpatient setting. Before the present study, the pediatric hospital medicine (PHM) service at Texas Children’s Hospital did not meet eligible provider or hospital MU standards, with a baseline e-prescribing frequency of only 7.8%. The aim of this study was to use a bundle of quality improvement (QI) interventions to increase e-prescribing frequency of discharge prescriptions on the PHM service to 40% (the Level 1 MU standard for eligible providers) within a 6-month time period and to sustain this level throughout the next academic year. The eligible provider target was selected in an effort to change and sustain individual provider practices. The eligible hospital stage 2 goal of 10% seemed too low to result in substantive changes in provider practices. Conversely, a goal of 100% would not account for medications ineligible for e-prescribing (controlled substances) or situations in which e-prescribing is not ideal (parents unsure of preferred pharmacy).

The main drivers for improving the e-prescribing frequency included geographic challenges of the PHM service (spanning 2 buildings and 10 clinical care units), hospital administration focus on MU (and corresponding US News and World Report points), and a desire to improve our patient experience and satisfaction.

**METHODS**

Setting

The study was conducted at the main campus of Texas Children’s Hospital, a large, urban, freestanding children’s hospital. The PHM service averages 4800 discharges per year, with 65% Medicaid patients, 25% managed care, and 10% self-pay. The majority of patients are admitted through the Emergency Center (EC). The PHM service comprises 4 teams, each ranging from 6 to 10 members, including faculty attending, pediatric residents, medical students, and sometimes PHM fellows. Each team provides care to patients located in multiple clinical care areas (up to 10 different units) across 2 buildings, which makes efficient delivery of signed paper prescriptions to the patient bedside challenging. This project involved buy-in from key stakeholders, including nursing, registration personnel, Information Services (IS) analysts, and physicians (resident, fellow, and attending physicians on the PHM service). Institutional review board approval was obtained.

Interventions

A needs assessment was conducted via anonymous surveys that were distributed to pediatric residents and volunteer patient families to identify perceptions of and barriers to e-prescribing. Subsequently, 2 focus groups constructed fishbone diagrams to illustrate barriers to e-prescribing (Fig 1) and created process maps to identify leverage points for improving inpatient e-prescribing. Key drivers identified included provider education, efficiency of inpatient workflow, and systems improvement of the EHR (Fig 2).

Education Bundle

Surveys revealed misconceptions about residents’ ability to e-prescribe in the inpatient setting. To address this issue, the first bundle of interventions included a tutorial presented at the pediatric resident noon conference, prescription resource tip sheets, and monthly e-mail reminders. The e-mails and tutorial highlighted common e-prescribing pitfalls and tips for efficiency. All education files were made electronically available to residents and PHM faculty, and reminder e-mails were regularly sent to all levels of providers.

EHR Interventions

The resident surveys identified the absence of a preferred pharmacy in the patient’s EHR as a barrier to e-prescribing. EC registration...
personnel were trained on entering this information, and it was added to their EHR workflow. Registration was a logical area for intervention because personnel already input patients’ pediatrician information and other demographic data in the EHR.

Another intervention included an EHR build requiring residents to assign an authorizing attending provider for discharge prescriptions, whether printed or e-prescribed. This action ensured that attending information would be linked to all prescriptions for appropriate insurance processing and follow-up. Before this intervention, residents had to manually write in the attending name on printed prescriptions but could not do so when e-prescribing, limiting its functionality.

The other major EHR intervention was to make e-prescribing the default method of prescription for all providers system-wide, thus forcing providers to actively opt out of e-prescribing. The build included an in-line validation to ensure that prescription orders were eligible for e-prescribing (scheduled controlled substances not eligible at the time of the project) and that all necessary information (ie, preferred pharmacy) was present.

**Study of the Interventions**

Three periods were compared: (1) a baseline phase of 30 weeks (July 1, 2014–January 25, 2015); (2) the implementation phase spanning 22 weeks (January 26, 2015–June 28, 2015); and (3) a sustainability phase of 27 weeks (June 29, 2015–December 31, 2015). Interventions occurred from January to April 2015, with the timing of the education bundle strategically planned with the pediatric chief residents. Despite high census in January, interns were familiar with the EHR by then, and the holiday season had passed. EHR interventions occurred at the earliest possible date based on IS and registration capabilities (Table 1).

**Measures**

The primary outcome measure was the frequency of electronic discharge prescriptions from the PHM service. This frequency was calculated by dividing the number of e-prescriptions (e-prescribing orders) by the total number of discharge prescriptions (e-prescribing, print, phone-in, and no print order classes). Historical or over-the-counter medications

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**FIGURE 1**

Fishbone diagram of barriers to electronic prescribing.
were excluded because they did not require actual prescriptions at discharge. Prescription information was obtained from a de-identified weekly report generated in the EHR.

E-prescribing frequency in a resident outpatient clinic was used to account for concurrent practice trends or other institutional and technological factors that may have influenced e-prescribing frequency. The frequency of EC patients registered with a preferred pharmacy served as a process measure to monitor the success of the new registration workflow.

As a balance measure, the PHM e-prescription error frequency (errors involving PHM discharge prescriptions divided by total PHM discharge e-prescriptions) was tracked to ensure that e-prescribing did not lead to more errors. Error information was generated from monthly EHR reports and confirmed by manual review of EHR error message pools. Examples of errors include disruptions in electronic transmission of prescriptions due to connectivity issues and incomplete prescription orders lacking necessary information. Dosage errors were not included in the error pool, as they occur independently of the method of prescription. The frequency of e-prescription errors from the resident outpatient clinic was also monitored.

The project team included a key IS physician and an IS analyst who would be aware of any potentially confounding IS initiatives. There were no other projects or changes to e-prescriptions during the course of this study.

**Analysis**

Weekly e-prescribing frequencies were analyzed as a time series outcome variable in a statistical process control P chart by using Excel QI charts version 2.0.22 (Scoville Associates, Raleigh-Durham, NC). Special cause variation was identified by using standard control chart rules. After detecting special cause signals, the control limits for the P chart were calculated for baseline and with each significant change in
the time series. The control chart was annotated with initiation of interventions to note their impact on improvement. Statistical analysis was completed by using SPSS version 23 software (IBM SPSS Statistics, IBM Corporation, Armonk, NY). Statistical significance between the baseline and intervention phases was performed by using the Kruskal-Wallis test, with post hoc analysis of between-group significance performed by using the Mann-Whitney test. Statistical significance was defined as a \( P \) value < .05.

**RESULTS**

From July 2014 through June 2015, a total of 6148 discharge prescriptions were ordered for patients discharged from the PHM service. Of these, 3430 (56%) were written before any intervention, and the median baseline e-prescribing frequency was 7.4%. The education bundle was implemented in January 2015, with subsequent increases in e-prescribing frequency to 23.4%. The addition of the EHR interventions further increased e-prescribing frequency to 48.9%, which was sustained over the next 6 months despite the start of a new intern class (Fig 3).

There was a statistically significant increase in median e-prescribing frequency between the baseline, first intervention (education bundle), and second intervention (EHR changes) phases (Table 2). Post hoc analysis revealed highly significant differences \( (P < .001) \) between groups such that each phase was significantly different from the others (Table 3). There was no difference in e-prescribing frequency between the postintervention and sustainability periods \( (P = .30) \). When analyzing the outpatient resident clinic, there was no difference in frequency of e-prescribing throughout the study \( (P = .15) \).

During the study period, Texas Children’s Eligible Hospital MU Measure H205 increased from 5% (reporting period October 26, 2014–December 13, 2014) to 16% (reporting period July 25, 2015–October 22, 2015), which brought the hospital above the needed MU goal of 10%. The frequency of e-prescription errors on the PHM service, which served as a balance measure, remained unchanged during the study period at <2% \( (P = .20) \). EC preferred pharmacy entry was tracked as a process measure for successful incorporation of new

![FIGURE 3](https://example.com/figure3.png)

**Statistical process control chart of e-prescribing frequency on inpatient pediatric service.**

<table>
<thead>
<tr>
<th>TABLE 2 Median E-prescribing Frequency for Various Study Phases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase</td>
</tr>
<tr>
<td>Baseline</td>
</tr>
<tr>
<td>First intervention, education bundle</td>
</tr>
<tr>
<td>Second intervention, EHR changes</td>
</tr>
<tr>
<td>Sustainability</td>
</tr>
</tbody>
</table>

<sup>a</sup> Met special cause variation on statistical process control chart.
registration EHR workflow. Before implementation, the number of EC patients with a preferred pharmacy listed was consistently <30%; after the change, this level increased to 42% (Fig 4).

**DISCUSSION**

To our knowledge, no previous studies have examined the use of QI methods to increase the frequency of e-prescribing in the inpatient setting. We found that a bundle of interventions increased e-prescribing on the PHM service, an improvement that was sustained for an additional 6 months despite the beginning of a new academic year with new interns.

As e-prescribing frequency increased, e-prescribing errors remained low, reflecting no adverse impact on patient safety. The interventions likely succeeded in changing practice because they directly addressed barriers and concerns raised by front-line providers and combined education with hard-wired EHR changes. Although e-prescribing rates increased substantially, providers continue to opt out one-half of the time because of barriers identified in the preintervention surveys that were not affected by this QI project. These persistent barriers include ineligible medications, parental preference for printed prescriptions, after-hours prescriptions (written after preferred pharmacy closed), and parental uncertainty of preferred pharmacy location. A strength of the study was the large number of prescriptions written. We were also able to identify a comparison group to account for any temporal institutional changes. The fact that e-prescribing frequency in the outpatient resident clinic remained stable during this study suggests that our QI project was responsible for the increase in PHM e-prescribing, rather than other institutional or environmental factors. During the focus group sessions, residents routinely reported e-prescribing in the outpatient setting but not in the inpatient setting due to the barriers highlighted. Therefore, eliminating these barriers improved inpatient e-prescribing practices while minimally affecting outpatient prescriptions. Because outpatient e-prescribing frequency in the resident clinic was already high, we did not expect our system-wide interventions to significantly affect practice patterns there.

The present study highlights the importance of engaging front-line providers such as residents and hospitalists in initiatives involving their workflows. Although these providers may not be directly eligible for incentive programs, their actions directly affect hospital metrics. Furthermore, residency is a time to teach best practices so residents are better equipped to be independent practitioners (and potentially future eligible providers) upon graduation. As the bedside providers in many institutions, they have a unique and often overlooked perspective about daily care workflows (and excellent ideas for how to improve them). Our study shows that QI methods can help identify barriers to resident e-prescribing and implement changes to overcome them.

This project also brought to light many system-wide EHR e-prescription errors and lack of

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**TABLE 3** Comparison of Median E-prescribing Frequencies According to the Mann-Whitney Test

<table>
<thead>
<tr>
<th>Phase Comparisons</th>
<th>Median E-prescribing Frequency, %</th>
<th>Median E-prescribing Frequency, %</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline versus first intervention</td>
<td>7.4</td>
<td>23.4</td>
<td>&lt;.001*</td>
</tr>
<tr>
<td>Baseline versus second intervention</td>
<td>7.4</td>
<td>51.2</td>
<td>&lt;.001*</td>
</tr>
<tr>
<td>Baseline versus combined intervention (first and second)</td>
<td>7.4</td>
<td>45.4</td>
<td>&lt;.001*</td>
</tr>
<tr>
<td>Baseline versus sustainability</td>
<td>7.4</td>
<td>48.0</td>
<td>&lt;.001*</td>
</tr>
<tr>
<td>First intervention versus second intervention</td>
<td>23.4</td>
<td>51.2</td>
<td>&lt;.001*</td>
</tr>
<tr>
<td>Combined interventions (first and second) versus sustainability</td>
<td>45.4</td>
<td>48.0</td>
<td>.30</td>
</tr>
<tr>
<td>First intervention versus (second intervention and sustainability)</td>
<td>23.4</td>
<td>48.9</td>
<td>&lt;.001*</td>
</tr>
</tbody>
</table>

* Statistically significant difference between phases.
processes to monitor and resolve such errors. Before the study, errors were being solved individually, but there was a lack of process or oversight to trend them and systemically intervene. Processes and personnel have now been enacted to trend, monitor, analyze, and correct e-prescribing errors.

Our project likely had an effect in the inpatient setting beyond the PHM service, both on resident prescribing practices on other services and overall provider prescribing practices with the system-wide EHR change of defaulting to e-prescribe. Forcing providers to consciously opt out of default preferred practices such as e-prescribing is effective in changing practice. The potential exists that our project also affected outpatient e-prescription rates for clinics that had low frequency e-prescriptions, but we did not specifically track those metrics. Our interventions on the PHM service led to an increase in hospital-wide e-prescribing frequency, allowing the hospital to meet its goal and thus earn additional points in the US News and World Report ranking system.

A limitation of this study is the inability to monitor whether patients actually obtained their medications; we could only track whether the prescription was electronically received by the pharmacy. Ideally, future research would study the effect of e-prescribing on patient outcomes, including compliance, readmissions and return EC visits, and treatment failures. In addition, although we were able to increase EC documentation of preferred pharmacy, the frequency remained suboptimal and could be further improved, which could allow e-prescribing rates to surpass 50%. Future directions include increasing e-prescribing among other provider groups, such as surgical specialties, emergency medicine, or pediatric subspecialty clinics, each of whom likely have their own specific barriers to e-prescribing. Future initiatives should engage front-line providers such as residents to ensure accurate identification of barriers and implementation of effective interventions.

**CONCLUSIONS**

Engaging front-line providers in hospital-wide initiatives and QI interventions can directly impact hospital metrics in programs such as Meaningful Use and *US News and World Reports*, as shown through the PHM e-prescribing frequency improvement demonstrated here. Future studies are necessary to determine whether increased e-prescribing frequency impacts patient outcomes and compliance.

**ACKNOWLEDGMENTS**

The authors thank Dr Andrea Cruz for her review of the manuscript. They also thank the Clinical Technology Council at Texas Children’s Hospital for their support of this project.

**ABBREVIATIONS**

EC: Emergency Center  
EHR: electronic health record  
IS: Information Services  
MU: meaningful use  
PHM: pediatric hospital medicine  
QI: quality improvement

**REFERENCES**


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