

Grant Final Report

Grant ID: R18HS017029

Electronic Prescribing and Electronic Transmission of Discharge Medication Lists

Inclusive Dates: 09/30/07 – 08/31/11

Principal Investigator:

Rainu Kaushal, MD, MPH

Team Members:

Erika L. Abramson, MD, MS^{* † ‡ §}
Vaishali Patel, PhD, MPH^{* † ‡ §}
Sameer Malhotra, MD, MA^{† §}
Elizabeth R. Pfoh, MPH^{† §}
S. Nena Osorio, MD^{* † §}

Adam Cheriff, MD^{† **}
Karen Fischer, RN^{† **}
Alison Edwards, MStat^{* † §}
Arwen Bunce, MA^{†† §§}
Joan Ash, PhD, MLS^{§§}

* Department of Pediatrics, Weill Cornell Medical College, New York, NY

† Department of Public Health, Weill Cornell Medical College, New York, NY

‡ New York-Presbyterian Hospital, New York, NY

§ Health Information Technology Evaluation Collaborative (HITEC), New York, NY

** Department of Medicine, Weill Cornell Medical College, New York, NY

†† Department of Family Medicine, Oregon Health & Science University, Portland, Oregon

§§ Department of Medical Informatics and Clinical Epidemiology, Oregon Health & Science University, Portland, Oregon

Performing Organization:

Weill Cornell Medical College

Project Officer:

Erin Grace

Submitted to:

The Agency for Healthcare Research and Quality (AHRQ)

U.S. Department of Health and Human Services

540 Gaither Road

Rockville, MD 20850

www.ahrq.gov

Abstract

Purpose: To measure the impact of health information technology (HIT) and health information exchange (HIE) on ambulatory patient safety.

Scope: This study evaluated the effects of transitioning from a locally-developed to a commercial electronic health record (EHR) with electronic prescribing (e-prescribing) and evaluated the effect of a novel HIE intervention on patient safety.

Methods: We conducted detailed prescription reviews over time to identify errors made by providers who transitioned between EHRs. We conducted semi-structured interviews, field observations, and surveys of providers to understand the impact of this transition on human-computer interactions. Using a cohort controlled design, we compared the effects of a novel HIE intervention on medication discrepancies and adverse drug events for patients transitioning from the inpatient to outpatient setting.

Results: We found that the transition to a commercial EHR with more robust clinical decision support (CDS) for e-prescribing decreased errors, largely by reducing inappropriate abbreviations. When these were excluded, errors actually increased initially and were only lower 2 years post-implementation. Providers had great difficulty with the transition, despite being experienced e-prescribers. Lastly, we found that medication discrepancies are extremely common, affecting the majority of patients transitioning from the inpatient to outpatient setting. A novel HIE intervention did not reduce medication discrepancies for those patients.

Key Words: ambulatory, electronic prescribing, safety, medication discrepancies

The authors of this report are responsible for its content. Statements in the report should not be construed as endorsement by the Agency for Healthcare Research and Quality or the U.S. Department of Health and Human Services of a particular drug, device, test, treatment, or other clinical service.

Final Report

Purpose

The purpose of this project was to measure the impact on ambulatory prescribing safety of transitioning between EHR systems for prescribing, as well as to evaluate the effect of a novel HIE intervention in reducing medication discrepancies and adverse drug events for patients transitioning between the inpatient and the outpatient setting.

The specific aims of this project were:

1. To measure the effects of transitioning from one to another new electronic prescribing system in the ambulatory setting on medication errors and human-computer interactions
2. To evaluate the impact of electronic transmission of medication lists at discharge from the hospital to the ambulatory setting on medication discrepancies at the first ambulatory visit follow discharge and adverse drug events 30 days post-discharge

Scope

Background and Context

Overview. The federal government is investing billions of dollars to promote meaningful use of electronic health records (EHRs) in an effort to improve healthcare safety.¹ To receive federal financial incentives, providers must use electronic prescribing (e-prescribing). It is hoped that use of e-prescribing will improve ambulatory medication safety, as medication errors in the ambulatory setting occur frequently, are often preventable, and are associated with significant patient harm.² Most of the literature documenting the success of health information technology (HIT) interventions including e-prescribing has been driven by a few institutions that used locally-developed systems and iteratively refined them over several decades.³ The ability to generalize those findings to commercial systems that are more accessible to other institutions and community-based providers is unclear. The effect of institutions transitioning from locally-developed systems to newer applications is also unclear.

Another important component of the meaningful use incentive program is health information exchange (HIE). HIE is intended to improve coordination of care, which is critically important given the fragmented healthcare that many Americans receive. One particularly vulnerable time for patients is the transition between care settings, such as the inpatient to the outpatient setting.⁴ Use of HIT and HIE to improve care transitions represents an important opportunity to improve patient safety. The purpose of this grant was to measure the impact of HIT and HIE on patient safety in the ambulatory setting.

Alignment with the Goals of the Agency for Healthcare Research and Quality

This project addressed the overall purpose of the Ambulatory Safety and Quality (ASQ) program, which is to use HIT to improve the safety and quality of health care in ambulatory and transitional care settings. The project also addressed the specific goals of the Improving Quality through Clinician Use of Health IT arm: to consider the effect of health IT outcomes in ambulatory settings and across high-risk transitions of care, to investigate evaluate existing strategies for clinician use of health IT in the ambulatory settings, and to examine essential strategies for safe, successful, and productive health IT adoption in ambulatory settings.

Furthermore, this project addressed several AHRQ areas of interest for Improving Quality through Clinician Use of Health IT grants. These included improved outcomes through more effective clinical decision support and medication management, as well as demonstration of the ability of EHRs to effectively move more evidence-based information to the point of care, including participating in health information exchanges.

Settings and Participants

The specific aims of this project were conducted in the ambulatory setting, specifically the Ambulatory Care Network (ACN) of New-York Presbyterian Hospital, which is a large tertiary care academic medical center hospital located in New York City. Patients and providers were recruited from a large office practice in the ACN, which has 30 attending physicians, 135 residents, and 4 nurse practitioners. The office practice has over 60,000 patient visits per year and serves diverse patient populations—approximately half of patients are Hispanic or African American. In addition, over half of patients have Medicare or Medicaid insurance. There is also a substantial amount of chronic disease, with hypertension accounting for 30% of visits and diabetes accounting for 16% of visits. Conducting the project in this setting allowed the project to capture one of the required ASQ outcome measures: the impact of HIT in a low-resourced setting and addressed population requirements for working with vulnerable populations. Of note, providers at this site transitioned from a locally developed EHR with minimal CDS for e-prescribing to a commercial EHR with robust CDS for e-prescribing in April 2008. Extensive technical support and training for providers was led by the information systems team responsible for the transition.

Incidence, Prevalence, and Alignment with Institute of Medicine Priority Areas

This project measured whether patients were receiving appropriate care for prevention, treatment, and management of the Institute of Medicine (IOM) priority area medication management—a required outcome measure for ASQ grants. This project also addressed care coordination, another priority area for the IOM. It did so by use of a novel HIE to attempt to decrease medication discrepancies and adverse drug events (ADEs) for patients transitioning between the inpatient and outpatient setting.

Medication use in the United States is widespread. Medication errors in the ambulatory setting are common, occurring in approximately 8-28% of prescriptions.⁵⁻⁷ Adverse drug events

(ADEs) in the ambulatory setting are also common, affecting 25% of patients.⁸ Of those ADEs in the ambulatory setting, 11% are preventable and 28% are ameliorable. A particularly vulnerable time for patients, in terms of risk for ADEs, are transitions across care settings due to hand-offs. ADEs after hospital discharge are very common, with rates as high as 13-17% for patients within 30-days of discharge.^{9,10}

Methods and Results (Specific Aim 1)

Study Design

The goal of specific Aim 1 was to measure the effects of transitioning between EHRs with e-prescribing in the ambulatory setting on rates and types of medication errors (Study 1) and human-computer interactions (Study 2). Study 1 used a before-and-after prospective study design to compare rates and types of prescribing errors at baseline (on the locally-developed system) and 3 months, 1 year, and 2 years post-transition to a commercial EHR. For Study 2, we conducted qualitative research comprised of one-on-one interviews and direct observation of providers. We also developed a novel survey instrument that was administered to providers to compare their experiences on the old and new system. We describe each study separately below.

Data Sources/Collection (Study 1)

For Study 1, Specific Aim 1, we reviewed prescriptions written by all 19 faculty providers at the adult general internal medicine clinic practice described above who worked 75% time or more and at least 2 clinic sessions per week. Electronic prescriptions were extracted from each EHR's database during a two week period in each of four study intervals: baseline (pre-implementation of the commercial EHR), 12 weeks post-implementation, one year post-implementation, and two years post-implementation. Prescriptions written by residents were excluded. We obtained a minimum of 75 prescriptions on 25 patients per provider, extending data collection beyond two weeks if necessary. We limited review to 3 prescriptions per patient to minimize clustering of errors.

Two nurse reviewers were trained in an identical manner by one investigator with extensively utilized and standardized methodology. This included review of error definitions and review of test and actual cases. Both nurses jointly reviewed cases initially, after which the investigator observed them separately and remained available for questions. Methodology included error classifications and identification of ADE trigger drugs. We conducted physician reviews for all suspected near misses and ADEs. Confirmed ADEs were rated on preventability using a 5-point Likert scale and on attribution using the Naranjo algorithm, which uses factors such as known medication side-effect profiles, timing of patient reported symptoms, and documented use of antidotes to assess attribution.

Intervention (Study 1)

All providers transitioned to a Certification Committee for Health Information Technology (CCHIT)-certified ambulatory EHR with integrated e-prescribing. The commercial system had advanced CDS including provision of default dosages and alerts for allergies and drug-drug interactions, as well as electronic transmission of prescriptions to pharmacies. Providers could also create preference lists (lists of frequently used orders) as well as order sets (pre-populated groups of medications). In comparison, the only CDS available on the locally-developed system was provision of default formulations.

Measures (Study 1)

The main outcome measures were rates and types of prescribing errors.

Principal Findings and Outcomes (Study 1)

We reviewed 1298 prescriptions at baseline (on the locally-developed EHR), 1331 prescriptions at 3 months, 1303 prescriptions at 1 year, and 1885 prescriptions at 2 years. We found that prescribing errors were highest at baseline and lowest 2 years post-implementation (42.8 errors per 100 prescriptions at baseline versus 3.7 errors per 100 prescriptions at 2 years, $p < 0.001$). Excluding the most common type of error, inappropriate abbreviation errors, we found that error rates were actually highest 12 weeks post-implementation (8.0 errors per 100 prescriptions, CI 5.8-11.2) and no different at one year than at baseline (4.9 errors per 100 prescriptions at one year, CI 3.5-6.7, versus 3.9 errors per 100 prescriptions at baseline, CI 2.8-5.4, $p = 0.34$).

Conclusions and Significance (Study 1)

This study is the first to our knowledge to evaluate the effect on ambulatory prescribing safety of transitioning between a locally-developed EHR with minimal CDS for e-prescribing to a commercial EHR with robust CDS for e-prescribing on ambulatory prescribing safety. Use of e-prescribing is one of the core meaningful use criteria.¹ For providers transitioning from paper, commercial EHR systems with e-prescribing capability are likely to be adopted as these systems are readily available and accessible. Some organizations previously using locally developed systems are also transitioning to commercial systems to increase interoperability, be eligible for incentives, and utilize technical support and product development services of outside vendors.

Our results suggest that transitioning between systems, even to those with more robust CDS for prescribing, may pose important safety threats. Over time, as users become accustomed to a system and iterative refinements are made, safety may improve. Recognizing the challenges associated with transitions and refining CDS within systems may help maximize safety benefits. Understanding the effects will be informative for organizations and providers undergoing this type of transition and allow potential safety threats to be better anticipated and managed.

The results for the first 3 data collection periods (baseline, 12 weeks post-implementation, and one year post-implementation) have been published in the *Journal of General Internal Medicine*.¹¹ The results inclusive of two year post-implementation have been presented at the

American Medical Informatics Association annual conference and are currently being prepared for publication.

Data Sources/Collection (Study 2)

For Study 2, we conducted both field observations of providers using the commercial EHR and semi-structured interviews. Field observations were conducted 9 months post-implementation of the commercial system, and semi-structured interviews were conducted at 9 months and two years post-implementation. These complementary approaches allowed us to develop a rich description of a small group of physicians' experiences.

For the field observations, researchers unobtrusively observed each physician for 2-3 hours using the commercial EHR. We recorded observations on field guides developed for this study. Our field observations were particularly focused on aspects related to e-prescribing, such as work flow, system interfaces for e-prescribing, CDS, and physician efficiency in ordering and refilling medications. For the semi-structured interviews, questions focused on the interviewee's comfort with health information technology, e-prescribing experiences using the two systems, and implementation and training. We also asked probing questions and questions based on field observations. Interviews were audio-recorded and transcribed.

Intervention (Study 2)

As described above, all providers transitioned to a Certification Committee for Health Information Technology (CCHIT)-certified ambulatory EHR with integrated e-prescribing. The commercial system had advanced CDS including provision of default dosages and alerts for allergies and drug-drug interactions, as well as electronic transmission of prescriptions to pharmacies. Providers could also create preference lists (lists of frequently used orders) as well as order sets (pre-populated groups of medications). In comparison, the only CDS available on the locally-developed system was provision of default formulations.

Main Measures (Study 2)

We analyzed field notes of observations and transcripts of semi-structured interviews using qualitative methods guided by a grounded theory approach. We identified key themes describing physician experiences.

Principal Findings and Outcomes (Study 2)

During the first round of data collection at 9 months post-implementation of the commercial EHR, six major themes emerged from the data. One theme related to implementation, training, and technical support for a new EHR system. The rest compared e-prescribing between the two systems. At both time periods, we also asked physicians about their adoption and use of electronic prescribing and clinical decision support, which are required outcome measures for Improving Quality through Clinician Use of Health IT grants.

With regard to usage, at both time periods, greater than 90% of physician prescribers reported using e-prescribing to complete 75%-100% of their prescriptions. However, the

majority of physicians reported that the clinical decision support alerts were rarely useful, and less than 10% reported that the clinical decision support alerts were almost always or often useful.

In terms of their experiences transitioning between and using the two systems, we found that most physicians considered the transition extremely difficult, despite the fact that they were experienced e-prescribers and that there was intensive work done by the information systems team at the ACN to ease the transition. Although a few features of the commercial system were highly valued, such as the ability to access the system remotely and to have shared medication lists with subspecialists, the majority of physicians preferred a much simpler system. Physicians also did not perceive the commercial EHR as improving prescribing safety, despite its more robust CDS for e-prescribing, largely due to alert fatigue. Results from this analysis were presented at the Academy Health Meeting in 2010. Results from this analysis are currently under review at a peer-reviewed journal.

At two years post-implementation, we again conducted semi-structured interviews of physicians to understand how their perspective evolves over time. We found that the transition to the commercial EHR resulted in perceived decreases in productivity and efficiency long after go-live. Over time, providers became more positive in their perceptions about the new system, including its perceived impact on safety, due to iterative refinements such as limiting of alerts and tall-man lettering. We also found that perceived system usability and efficiency for order writing remain key determinants of provider satisfaction. Results for this round of analysis were presented at the American Medical Informatics Association meeting in October 2011. A manuscript detailing results from this second round of data collection is near completion.

Conclusions and Significance (Study 2)

In order to be eligible to for federal meaningful use incentives, more providers and healthcare organizations will be transitioning between EHRs or upgrading to newer EHR system versions. Understanding physician experiences with this type of transition and their preferences for prescribing applications may lessen disruptions from system implementations and lead to better designed EHRs that are more readily accepted by providers. Our results suggest that there are unique challenges associated with transitioning between systems and recognition of these challenges may inform best practices for transitioning. This includes recognizing the substantial initial and ongoing training needs, even for experienced e-prescribers. Furthermore, an EHR with the capability of providing robust CDS may not be perceived to improve safety if alert fatigue is high. Finally, our study suggests that physicians' attitudes towards implementation and use of an EHR with e-prescribing are strongly related to perceived effects on workflow. Designing systems that focus on efficiency for prescribing and training providers on features that can increase their efficiency may improve provider satisfaction.

Methods and Results (Specific Aim 2)

Study Design

We used a cohort controlled design to evaluate the effect of a novel HIE intervention versus usual care on medication discrepancies and adverse drug events for patients transitioning from the inpatient to the outpatient setting.

Participants

Study participants were English or Spanish-speaking adults admitted to one of the inpatient medical units of the hospital who were discharged to home and followed up with a primary care or subspecialist provider who was part of the ACN. These providers all use the same outpatient EHR.

Intervention

The novel HIE intervention was an electronic alert notification that was sent directly to the ambulatory provider's EHR inbox notifying them that their patient had been hospitalized, that they had a follow-up appointment, and listing their discharge medication medications. This intervention was therefore specifically designed to address threats to medication safety for patients transitioning between healthcare settings by improving care coordination and medication management for those patients. For patients in the intervention arm, their provider received this alert notification prior to the patient's scheduled follow-up visit. For patients in the control arm, their providers did not receive the alert notification. Both groups of providers had access to the complete inpatient discharge summary via direct linkage into the outpatient EHR. This discharge summary was a comprehensive document that included discharge medications in addition to other fields such as hospital course, tests performed, diagnoses, problem lists, and follow-up appointments.

Data Collection/Sources

We performed 2 types of data collection: patient surveys and a manual review of each patient's EHR. Two surveys were conducted; the first survey was completed in person in the inpatient setting, assessed basic demographic information, health status, health coverage, and English proficiency. The second survey was conducted via telephone 1-2 months post discharge and included a detailed medication review and a report of patient symptoms post-discharge. This survey was used to identify medication discrepancies and potential ADEs.

A trained physician researcher then performed pair-wise comparison using the patient-reported medications via telephone survey to compare the discharge medication list and the medication list documented at the first follow up outpatient visit. The number of medications on each list and any discrepancies between the three lists were recorded. Whenever discrepancies were noted, a physician researcher documented the differences in the drug, dose, route and frequency and the location at which the discrepancy occurred. Patient symptoms were also

assessed to determine whether or not these were likely to be ADEs and if they were related to a medication discrepancy. For all discrepancies, the outpatient EHR was reviewed for documentation that might explain the discrepancy and to further evaluate for potential sequelae.

Main Measures

The main outcome measures were medication discrepancies and ADEs.

Principal Findings and Outcomes

162 subjects completed all parts of the study— 82 patients in the intervention arm, and 82 patients in the control arm. Overall, we found that medication discrepancies were extremely common. 68 patients (83%) in the control arm had at least one discrepancy and 65 patients (79%) in the intervention arm had at least one discrepancy ($p = 0.55$). Five patients (2%) experienced an ADE in the control group and 11 patients (4%) experienced an ADE in the intervention group ($p = 0.51$). Use of the novel HIE intervention did not significantly reduce medication discrepancies or adverse drug events for patients in the intervention group. Cardiovascular drugs, gastrointestinal drugs, non-narcotic analgesics, and anti-coagulants were the classes of medications with the highest discrepancy rates. The most common type of discrepancy that we detected was omitted medications (73% of all total discrepancies).

In a separate sub-analysis we performed to identify risk factors for medication discrepancies and ADEs, we found that taking eleven or more medications, having 2 or more outpatient visits during the previous year, having a less than high school education, and receiving care from an intern (as opposed to a more senior resident) were all independent risk factors for higher rates of medication discrepancies during the first follow-up visit.

Conclusions and Significance

Medication errors have emerged as a leading cause of morbidity and mortality, and transitions in patient care are a particularly vulnerable time for patients.^{10,12,13} One important source of medication errors is medication discrepancies. Given the high rates of medication discrepancies we found, our study underscores the importance of developing interventions that can facilitate the process of medication reconciliation. Designing interventions that integrate well within provider workflow and that will be subsequently be utilized during busy primary care encounters is challenging.

Our results also provide important information on the types of patients at greatest risk for medication discrepancies. This information can help providers identify those patients who need special attention to medication management in an effort to reduce their risk for harm from medication discrepancies. A manuscript detailing this work will be submitted for review shortly.

Relevance to AHRQ Priority Populations

The participants for this project were patients who received primary care in a large office practice that is part of the Ambulatory Care Network (ACN) of New-York Presbyterian Hospital. This population (described more fully in section 3, Scope/Setting and Participants) includes

several of AHRQ's priority populations, including low-income groups, minority groups, women and the elderly.

References

1. U.S. Department of Health and Human Services. HHS Announces Additional \$162 Million in Recovery Act Investment to Advance Widespread Meaningful Use of Health IT. 2010; www.hhs.gov/news/press/2010ores/03/20100315a.html. Accessed August 17, 2010.
2. Thomsen LA, Winterstein AG, Sondergaard B, Haugbolle LS, Melander A. Systematic review of the incidence and characteristics of preventable adverse drug events in ambulatory care. *The Annals of pharmacotherapy*. Sep 2007;41(9):1411-1426.
3. Ammenwerth E, Schnell-Inderst P, Machan C, Siebert U. The Effect of Electronic Prescribing on Medication Errors and Adverse Drug Events: A Systematic Review. *J Am Med Inform Assoc*. September-October 2008;15(5):585-600.
4. Clancy CM. Care transitions: a threat and an opportunity for patient safety. *Am J Med Qual*. Nov-Dec 2006;21(6):415-417.
5. Kaushal R, Kern LM, Barron Y, Quaresimo J, Abramson EL. Electronic Prescribing Improves Medication Safety in Community-Based Office Practices. *J Gen Intern Med*. Feb 26 2010.
6. Gandhi TK, Weingart SN, Seger AC, et al. Outpatient prescribing errors and the impact of computerized prescribing. *J Gen Intern Med*. Sep 2005;20(9):837-841.
7. Abramson E, Barron Y, Quaresimo J, Kaushal R. Electronic prescribing within an electronic health record reduces ambulatory prescribing errors. *Joint Commission Journal on Quality and Patient Safety*. 2011;37(10).
8. Gandhi TK, Weingart SN, Borus J, et al. Adverse drug events in ambulatory care. *The New England journal of medicine*. Apr 17 2003;348(16):1556-1564.
9. Forster AJ, Murff HJ, Peterson JF, Gandhi TK, Bates DW. The incidence and severity of adverse events affecting patients after discharge from the hospital. *Ann Intern Med*. Feb 4 2003;138(3):161-167.
10. Forster AJ, Clark HD, Menard A, et al. Adverse events among medical patients after discharge from hospital. *Cmaj*. Feb 3 2004;170(3):345-349.
11. Abramson EL, Malhotra S, Fischer K, et al. Transitioning between electronic health records: effects on ambulatory prescribing safety. *J Gen Intern Med*. Aug 2011;26(8):868-874.
12. Kohn LT, Corrigan J, Donaldson MS, Institute of Medicine (U.S.). Committee on Quality of Health Care in America. *To err is human : building a safer health system*. Washington, D.C.: National Academy Press; 2000.
13. Forster AJ, Asmis TR, Clark HD, et al. Ottawa Hospital Patient Safety Study: incidence and timing of adverse events in patients admitted to a Canadian teaching hospital. *Cmaj*. Apr 13 2004;170(8):1235-1240.

List of Publications and Products

Publications

Abramson EL, Malhotra S, Fischer K, Edwards A, Reynolds E, Osorio S, Cheriff A, and R Kaushal. Transitioning Between Electronic Health Records: Effects on Ambulatory Prescribing Safety. *Journal of General Internal Medicine*. 2011 Aug;26(8):868-74.

Abramson EL, Patel V, Malhotra S, Reynolds E, Osorio S, Cheriff A, Bunce A, Ash J, and R Kaushal . Physician Experiences Transitioning Between an Older versus Newer Electronic Health Record for Electronic Prescribing. (Under review at the *International Journal of Biomedical Informatics*).

Osorio, SN, Abramson EL, Pfoh E, Edwards A, Schottle H, and R Kaushal. Risk Factors for Unexplained Medication Discrepancies During Transitions in Care (To be submitted to *FamilyMedicine*)

Abramson EL, Malhotra S, Fischer K, Edwards A, Pfoh E, Osorio S, Cheriff A, Cole Cand R Kaushal. Safety effects over time after transitioning between electronic health records (To be submitted to the *American Journal of Managed Care*).

Abramson EL, Pfoh E, Patel V, Malhotra S, Osorio S, Cheriff A, Bunce A, Ash J, and R Kaushal. Physician Experiences Over Time after transitioning between Electronic Health Records (To be submitted to *JAMIA*).

Abramson EL, Pfoh E, Osorio S, Malhotra S, Edwards A, Schottel H, Kaushal R. Effect of a Novel Health Information Exchange Intervention on Medication Safety for Patients Transitioning between Care Settings (To be submitted to *The Joint Commission Journal on Quality and Patient Safety*)

Related Publications

Ancker J, Kern L, Abramson E, Kaushal R. The triangle model for evaluating the effects of health information technology on healthcare quality and safety. *J Am Med Inform Assoc*. 2011 Aug 20. [Epub ahead of print]

Presentations

Abramson E, Patel V, Malhotra S, Reynolds E, Osorio S, Cheriff A, Ash J, Kaushal R. Physician Perspectives on Electronic Prescribing Using a Locally Developed Versus Commercial Electronic Health Record. AcademyHealth Annual Research Meeting, Boston, MA, June 2010 (poster presentation).

Pfoh ER, Abramson EL, Patel V, Malhotra S, Osorio SN, Cheriff A, Kaushal R. Physician Prescribing Experiences Over Time After Transitioning from an Older to a Newer

Electronic Health Record. Annual Symposium of the American Medical Informatics Association, Washington, DC, October 2011 (poster presentation).

Abramson EL, Malhotra S, Kischer K, Edwards R, Pfoh ER, Osorio SN, Cheriff A, Kaushal R. Transitioning Between Electronic Health Records: Effects on Ambulatory Prescribing Safety. Annual Symposium of the American Medical Informatics Association, Washington, DC, October 2011 (poster presentation).