Title of Project: Improving Post-hospital Medication Management of Older Adults through Health IT

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Organization: University of Massachusetts Medical School

Inclusive Dates of Project: 09/01/2007 – 08/31/2011

Federal Project Officer: Joy Basu, PhD

Grand Award Number: R18 HS017203

Structured Abstract

Purpose: The goals of this study were to evaluate, among a population of older adults, the impact of providing information through an HIT-based transitional care intervention on the rate of follow-up to an outpatient provider within 14 days of hospital discharge, the prevalence of appropriate monitoring for selected high-risk medications at 45 days from the time of hospital discharge, the incidence of adverse drug events (ADEs) through 45 days following discharge, and the rate of hospital readmission and emergency department (ED) visits within 30 days of discharge.

Scope: Multiple factors contribute to problematic medication management following acute care, including poor physician-patient communication and education regarding medication use, poor therapeutic monitoring, and incomplete or inaccurate information transfer between clinicians. During care transitions, patients receive medications from different prescribers, who often lack access to patients' comprehensive medication lists. In addition, lack of appropriate follow-up care exacerbates problems during this vulnerable period.

Methods: We conducted a randomized controlled trial of an HIT-based transitional care intervention that included alerts about key therapeutic changes and monitoring recommendations in the setting of a large multispecialty group practice. We tested this intervention in adults, aged 65 and older, discharged from the hospital to the ambulatory setting. Randomization of the HIT-discharge communication occurred at the time of hospital discharge.

Results: We did not find significant improvements in visits to the outpatient provider following discharge from the hospital, laboratory monitoring in response to alerts, adverse drug event rates, or rehospitalization and emergency department visit rates relating to the intervention.

Key Words: ambulatory care, health information technology, medication safety, post-hospitalization transitions

Purpose

Objectives of the Study

The incidence of drug-induced injury is high in the ambulatory geriatric population, especially for elders upon transition from the hospital to the ambulatory setting. In this study, performed under the Agency for Healthcare Research and Quality RFA entitled **Ambulatory Safety and Quality Program: Improving Quality through Clinician Use of Health IT** (RFA-HS-07-006), we developed and evaluated an HIT-based medication transitional care intervention linked to the ambulatory electronic medical record (EMR). Our focus was the transition from the inpatient to the ambulatory setting by older adults with multiple comorbid conditions, especially those prescribed high-risk medications.

Our intervention was designed to address the special challenges in complex information management and coordination of data sharing across multiple settings that hamper clinician workflow in the post-hospitalization setting. Specifically, our HIT-intervention was designed to automate key steps in the transition of care from the hospital to home, including: 1) expediting and facilitating discharge follow-up appointment scheduling; 2) facilitating medication reconciliation by highlighting key therapeutic changes; and 3) generating patient-specific therapeutic monitoring recommendations for high-risk medications in the post-hospitalization period.

We performed a <u>randomized controlled trial</u> of the HIT-based transitional care intervention in a patient population particularly vulnerable to preventable adverse events in the ambulatory setting, patients aged 65 and older recently hospitalized and discharged to home. We postulated that the efficient and coordinated delivery of actionable health information to the clinician via use of HIT in the ambulatory setting would improve medication safety for older patients.

The specific aims for this study were to evaluate, among a population of older adults, the impact of the HIT-based transitional care intervention:

(1) on the rate of follow-up to an outpatient provider within 14 days of hospital discharge.
   Hypothesis 1: The rate of 14-day hospital discharge follow-up visits will be greater for the patients randomized to automated scheduling alerts.
(2) on the prevalence of appropriate monitoring for selected high-risk medications at 45 days from the time of hospital discharge.
   Hypothesis 2: The prevalence of appropriate monitoring at 45 days will be higher for patient discharges randomized to automated monitoring alerts.
(3) on the incidence of adverse drug events (ADEs) 45 days after discharge.
   Hypothesis 3: The 45-day rate of ADEs will be lower for patient discharges randomized to an HIT-based transitional care intervention.
(4) on the rate of hospital readmission and emergency department (ED) visits within 30 days of discharge.
   Hypothesis 4: The prevalence of rehospitalizations and ED visits within 30 days of discharge will be lower for patient discharges randomized to an HIT-based transitional care intervention.

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Secondary aims for this study were to: 1) to assess whether an HIT-based transitional care intervention was more effective in subgroups of patients (by level of comorbidity, number of medications, and use of specific high risk medications); and 2) to determine costs directly related to the development and installation of the HIT-based transitional care intervention.

This study would not have been possible if not for a longstanding and successful collaborative relationship between investigators at the University of Massachusetts Medical School, a large multispecialty medical group (Fallon Clinic of Worcester, Massachusetts, which is now known as Reliant Medical Group), and Fallon Community Health Plan (FCHP).

Scope

Background

Medication Utilization Patterns of Older Adults

Older adults are burdened by more chronic medical conditions and use substantially more medications in comparison to younger persons. Eighty-eight percent of people aged 65 years or older have one or more chronic illnesses, and one quarter of these individuals have four or more conditions.[1] According to the most recent Slone Survey, nearly 60% of U.S. adults aged 65 or older in the ambulatory setting take at least 5 different mediations per week, and over 15% take at least 10.[2] The use of multiple concurrent drug therapies is frequently necessary and appropriate in the care of the elderly patients with multiple medical problems to optimize medical and functional status. However, suboptimal use of medications brings with it an increased risk for medication errors and the occurrence of adverse drug events.

Adverse Drug Events in the Elderly are Common in the Ambulatory Setting

Adverse drug events (ADEs), especially those that may be preventable, are among the most serious concerns about medication use in older persons cared for in the ambulatory clinical setting.[3] A U.S. national surveillance study of emergency department visits for outpatient adverse drug events indicated that individuals aged 65 years or older were 2.4 times more likely than younger individuals to sustain adverse drug events, and nearly 7 times more likely to require hospitalization.[4] There is a dose-response relationship with comorbidity, number of medications and the incidence of preventable adverse drug events.[5] Twenty percent of preventable adverse drug events in the ambulatory setting among older adults relate to patient errors including administering the medication incorrectly, modifying the medication regimen, or not following clinical advice about medication use.[6] Adverse drug events are particularly common after acute hospitalizations,[7-8] when multiple medication changes occur and may contribute to confusion regarding medication management among patients and physicians.[9] In one study that examined the influence of hospitalization on drug therapy in older patients, 40% of all admission medications were discontinued by discharge, and 45% of all discharge medications were newly started during the hospitalization.[10] It is estimated that 12% to 17% of general medicine patients experience ADEs after hospital discharge, more than half of them preventable.[7-8]

In summary, multiple factors contribute to problematic medication management following acute care, including poor physician-patient communication and education regarding medication use,[11] poor therapeutic monitoring,[3, 12] and incomplete or inaccurate information transfer

between clinicians.[13] During care transitions, patients receive medications from different prescribers, who often lack access to patient's comprehensive medication lists.[14] In addition, lack of appropriate follow-up care exacerbates problems during this vulnerable period.

Context, Setting, Participants

Overview

We conducted a <u>randomized controlled trial</u> of an HIT-based transitional care intervention that included alerts about key therapeutic changes and therapeutic monitoring recommendations in the setting of a large multispecialty group practice. We tested this intervention in adults, aged 65 and older, discharged from the hospital to the ambulatory setting. Randomization of the HIT-discharge communication occurred at the time of hospital discharge.

Study Site and Setting

This study was conducted in the setting of a large multispecialty group practice (the Fallon Clinic, now known as Reliant Medical Group) closely aligned with a non-profit, Central Massachusetts-based health plan (Fallon Community Health Plan). The group practice employs 330 outpatient clinicians, including 250 physicians at 23 ambulatory clinic sites covering 30 specialties. The group provides care to approximately 180,000 individuals, many of whom are members of an associated health plan with which the group practice shares financial risk. During the course of this study, the practice used the EpicCare Ambulatory EMR®, versions Spring 2007 IU3 and Summer 2009 IU6. Hospital care was delivered by hospitalists employed by the medical group.

Study population

The study population was derived from the Fallon Community Health Plan Senior Plan membership (n=31,469), the majority of whom received their care from the multispecialty group (n=25,942). The age and gender characteristics of the study population (n=25,942) were similar to those of the general population of the United States aged 65 or older (Table 1). Although race characteristics of Fallon Community Health Plan members are not systematically captured, market research indicates a patient racial mix consistent with the Central Massachusetts area. Among the entire population in Central Massachusetts, whites comprise 79% of the population, Hispanics 12%, African Americans 5%, and other races 4%. For those aged 65 or older, whites comprise 95.2%, Hispanics 2%, African Americans 2% and other races 0.8%.

Table 1. Age and Gender Characteristics of Study Population vs U.S. Population

Aged 65 and Older

	Study Population (n=25,942)			United States (n=36,294,000)		
Age Group	Male	Female	Total	Male	Female	Total
65 – 74	18%	23%	41%	24%	29%	53%
75 – 84	18%	25%	43%	14%	21%	35%
85 +	5%	11%	16%	3%	9%	12%
Total	**41%**	**59%**	**100%**	41%	59%	100%

Inclusion and Exclusion Criteria: For inclusion in our study, patients needed to meet the following criteria: 1) be 65 years or older at the time of discharge; 2) be discharged from the primary inpatient facility serving Fallon Community Health Plan Senior Plan members during the study period for a non-psychiatric condition (Saint Vincent Hospital of Worcester, Massachusetts); 3) have no plans to enter hospice upon discharge; and 4) be discharged back to the community (not to a skilled nursing facility or long-term care setting).

Methods

We conducted a randomized controlled trial of a HIT-based transitional care intervention that included alerts about key therapeutic changes and therapeutic monitoring recommendations in the setting of a large multispecialty group practice. We tested this intervention in adults, aged 65 and older, discharged from the hospital to the ambulatory setting. Randomization of the HIT-discharge communication occurred at the time of hospital discharge. The intervention period was from August 26, 2010 through August 25, 2011.

Intervention

The HIT-based intervention focused on key aspects of the transition of care from the hospital to the outpatient setting, with the provision of alerts and recommendations including: 1) alerts to the primary care provider about key therapeutic changes; 2) discharge follow-up appointment scheduling reminders to the secretarial staff; and 3) discharge medication monitoring alerts to the primary care provider.

While our original goal had been to develop a stand-alone workflow engine that took information from the EMR to generate an enhanced patient medication reconciliation list, this was not possible as the hospitalist physicians working in the inpatient setting conducted hospital discharge efforts specific only to the inpatient setting, and which could not be aligned with the EMR used in the care of patients in the ambulatory setting. As such, we relied on information

related to prescription fills by patients soon after discharge to generate alerts relevant to key therapeutic changes and therapeutic monitoring.

We developed an automated system to facilitate the flow of information to primary care providers. In addition to notifying providers about the patient's recent transition from hospital to home, the system was designed to provide information about new drugs added during the inpatient stay, based on the filling of prescriptions as described above, warnings about drug-drug interactions, and recommendations of dose changes and laboratory monitoring relating to high-risk medications, as well as to remind the primary care provider's support staff to schedule a post-hospitalization office visit. The team that selected the high-risk medications and developed monitoring guidelines consisted of a national advisory committee and local experts, including clinicians and pharmacists from the group practice.[15] Based on these guidelines, we constructed "blueprints" that contained the message content and criteria for triggering alerts and recommendations. Staff of the group practice medical informatics development team used the blueprints to guide the programming process.

The HIT intervention sent an alert to the outpatient clinician and the clinician's support staff notifying them of a hospital discharge and the need for a follow-up visit within 14 days of discharge. This approach was derived from models for other high-risk patients where improvements in discharge follow-up have been linked to improved health outcomes. If the patient was not seen by any outpatient provider within 14 days of discharge, a second (reminder) alert was sent to the clinician and front office staff.

Automated scheduling was considered but not chosen as a strategy because of concerns that this would lead to unnecessary duplication of appointments, and might increase the risk for no-shows in the clinic and needlessly assign valuable appointment time to persons with no need.

Measures

The measures relevant to this study were:

(1) The rate of follow-up to an outpatient provider within 14 days of hospital discharge in the intervention and control groups of patients.
(2) The prevalence of appropriate monitoring for selected high-risk medications at 45 days from the time of hospital discharge in the intervention and control groups of patients.
(3) The incidence of adverse drug events (ADEs) through 45 days following discharge in the intervention and control groups of patients. (Note that to this point, we have evaluated only the first 1000 hospital discharges for this measure.)
(4) The rate of hospital readmission and emergency department (ED) visits within 30 days of discharge in the intervention and control groups of patients. (Note that to this point, we have only evaluated the first 6 months of the intervention period for this measure.)
(5) The costs directly related to the development and installation of the HIT-based transitional care intervention.

In regard to adverse drug events (ADEs), hospital and ambulatory medical record reviews were performed by three trained clinical pharmacist investigators. Drug-related incidents occurring during the 1-45 day period following hospital discharge were considered relevant in the context of this study. Drug-related incidents occurring during the course of the hospitalization were not considered relevant.

All possible drug-related incidents were presented by a clinical pharmacist investigator (J.D., A.K.) to pairs of physician-reviewers (J.G., J.T., L.H., and S.C.). These physician-reviewers independently classified incidents using structured implicit review according to the following criteria: whether an adverse drug event was present, the severity of the event, whether the event was preventable, and the effects of the event on the patient. In determining whether an adverse drug event had occurred, the physician-reviewers considered the temporal relation between the drug exposure and the event, as well as whether the event reflected a known effect of the drug. The structured implicit review process has been used in numerous prior studies relating to adverse drug events across various clinical settings.

Severity of adverse events was categorized as less severe, serious, life-threatening, or fatal. Examples of less severe events include a nonurticarial skin rash, a fall without associated fracture, hemorrhage not requiring transfusion or management in and emergency department or hospital, and oversedation. Examples of serious events include urticaria, a fall with an associated fracture, hemorrhage requiring transfusion, emergency department care, or hospitalization but without hypotension, and delirium. Examples of life-threatening events include hemorrhage with associated hypotension, hypoglycemic encephalopathy, profound hyponatremia, and acute renal failure requiring hospitalization. Adverse drug events were considered to be preventable if they were due to an error and were preventable by any means available. Preventability was categorized as preventable, probably preventable, probably not preventable, or definitely not preventable; results were collapsed into preventable and nonpreventable categories in the analyses. The effects of adverse drug events on the patients were categorized as abnormal laboratory results without signs and symptoms, symptoms of less than 1 day in duration, symptoms of 1 day and longer in duration, nonpermanent disability, permanent disability, and death. Physician-reviewers characterized an event as causing permanent disability based on the potential for a drug-induced injury with permanent effects to cause physical disability or deficits in functioning.

We also classified the stages of pharmaceutical care during which an error leading to a preventable adverse drug event had occurred. The stages of pharmaceutical care in the ambulatory clinical setting were classified as prescribing, dispensing, patient adherence (eg, adherence to documented dosing or monitoring instructions provided by health care professionals), and monitoring. Monitoring stage errors include inadequate laboratory monitoring of drug therapies or a delayed response or failure to respond to signs or symptoms or laboratory evidence of drug toxicity. For a single adverse drug event, it was possible to identify errors at more than one stage of pharmaceutical care and/or to identify more than one error within a single stage of care.

When the physician-reviewers disagreed on the classification of an incident regarding the presence of an adverse drug event, its severity, or its preventability, they met and reached consensus; consensus was reached in all instances where there was initial disagreement.

Limitations

Our study has several limitations to this point. Due to delayed implementation of the intervention relating to several logistical and programming challenges, and an intervention period lasting from 8/26/2010 through 8/25/2011, we do not yet possess comprehensive administrative data from the health plan to allow us to assess the following measure for the entire study period: the

rate of hospital readmission and emergency department (ED) visits within 30 days of discharge in the intervention and control groups of patients (to this point, this measure has only been evaluated for the first 6 months of the intervention period, with analysis of the full one-year period pending). In addition, due to the resources required for identification and review of drug-related incidents during the 45 days following discharge, we have completed clinical pharmacist investigations and physician reviews for only the first 1000 hospital discharges. We fully intend to complete analyses relevant to the rate of hospital readmission and emergency department (ED) visits within 30 days of discharge for the entire study period. We are also working on procedures to promote efficiencies relevant to our ascertainment, review, and rating processes for adverse drug events.

Results

Principal Findings

The duration of the study period was 8/26/2010 through 8/25/2011. During that period, there were a total of 4524 hospital discharges that were eligible for inclusion in the study. There were 2285 in the intervention group and 2239 in the control group.

Visits to the outpatient provider: There were 873 visits to an outpatient provider within 14 days of hospital discharge among patients in the intervention group (38.2%), and 829 in the control group (37.0%) (relative risk = 1.0; 95% confidence interval: 0.96, 1.1). We also assessed whether there might have been more concerted efforts by the medical group to encourage follow-up visits with outpatient providers following hospital discharge over the course of the study period, exclusive of the HIT-based intervention, by examining whether there were differences during the first half of the study period (8/26/2010 – 02/26/2011), as compared with the second half (2/27/2011 – 08/25/2011). During the first half of the study period, there were 933 discharges and 420 visits to an outpatient provider within 14 days of hospital discharge among patients in the intervention group (45.0%), and there were 894 discharges with 378 visits in the control group (42.3%) (relative risk = 1.1; 95% confidence interval: 0.96, 1.2).

Laboratory monitoring: We found that the prevalence of appropriate monitoring for selected high risk medications within 45 days from the time of hospital discharge was very low in both the intervention (2.35%) and control groups of patients (1.11%) (relative risk = 1.3; 95% confidence interval: 0.56, 1.8). We are considering expanding the 45-day requirement, as it may be too stringent in a number of instances (e.g., liver function testing relevant to statin therapy), to more precisely assess the specific monitoring recommendations of the alerts.

Adverse drug events: We have comprehensively evaluated the first 1000 hospital discharges for all patients included in the study, with 514 discharges in the intervention group and 486 discharges in the control group. Among 514 discharges in the intervention group, we identified 107 discharges for which there was at least one adverse drug event during the 45-day period after discharge (20.8%). Among 486 discharges in the control group, we identified 82 discharges for which there was at least one adverse drug event during the 45-day period after discharge (16.9%) (relative risk =1.2; 95% confidence interval: 0.94, 1.6).

Hospital readmission and emergency department visits: In our analysis of the first 6 months of the intervention period (08/26/2010 – 02/26/2011), there were 933 discharges and 65 rehospitalizations in the 30-day period following hospital discharge among patients in the

intervention group (7.0%), and there were 894 discharges with 80 rehospitalizations in the 30-day period following hospital discharge among patients in the control group (8.9%) (relative risk = 0.78; 95% confidence interval: 0.56, 1.1). During the first half of the study period, there were 933 discharges and 125 emergency department visits in the 30-day period following hospital discharge among patients in the intervention group (13.4%), and there were 894 discharges with 114 emergency department visits in the 30-day period following hospital discharge among patients in the control group (12.8%) (relative risk = 1.1; 95% confidence interval: 0.82, 1.3).

Costs: The total estimate of costs for personnel involved in developing and implementing the transition intervention was $76,314. The time spent on the project across all personnel types was 1,308 hours. Physicians contributed over 600 hours which represented the largest component of time and costs. Their time includes overall project management, preparing the content, and reviewing and revising the alerts. The operations research analyst spent 370 hours developing the project's computer programs. The project required substantial coordination which was provided by a research assistant who also developed blueprints based on the guidelines. An EMR database administrator from the group practice contributed data to the discussions of content and provided information about existing data elements to the operations research analyst. The group practice pharmacist and a registered nurse contributed their perspective to the preparation of content and the review and revision process. Hours for maintenance during the initial four months were low, despite the fact that the EMR software was upgraded during that time. The resulting revisions to the alert system required very little time from the informatics team.

Discussion

We conducted a randomized controlled trial of an HIT-based transitional care intervention that included alerts about key therapeutic changes and therapeutic monitoring recommendations in the setting of a large multispecialty group practice. We tested this intervention in older adults, aged 65 and older, discharged from the hospital to the ambulatory setting. Randomization of the HIT-discharge communication occurred at the time of hospital discharge.

While a number of our analyses were limited to the first half of the study period, we did not find significant improvements in visits to the outpatient provider within 14 days following discharge from the hospital, laboratory monitoring in response to alerts, adverse drug event rates, or rehospitalization and emergency department visit rates relating to the intervention.

While we are continuing to complete analyses relevant to this study, we are considering a number of factors that may have contributed to the lack of an effect for the intervention. Despite an exhaustive effort, we were unable to alter the workflow of the hospitalist at the time of hospital discharge for the patient to allow for a fully implemented medication reconciliation process that would seamlessly be transmitted from the hospitalist to the ambulatory care provider. The primary care physician was only notified of new prescription medications that the patient filled subsequent to discharge and which were not already on the patient's medication list in the ambulatory electronic health record. This limitation may have led to the provision of incomplete information regarding new medications to the outpatient provider and also could have adversely impacted the potential benefits of the clinical decision support system relevant to laboratory monitoring. From our previous work, we also realize that the increasing numbers of alerts that ambulatory care providers face in utilizing EHRs lead to alert fatigue and providers may delete alerts without even reading or considering them. Having alerts relating to follow-up

appointments go to the office staff was a strategy to involve other members of the healthcare team; however, it remains unclear whether the office staff acted on the reminders and it is unlikely that follow-up appointments would be scheduled without interacting with the ambulatory provider, which may or may not have happened. As described in the Methods section above, automated scheduling was considered, but not chosen as a strategy, because this might have led to unnecessary duplication of appointments, and might have increased the risk for no-shows in the clinic and needlessly assign valuable appointment time to persons who had no need. In retrospect, however, this may have been the wrong strategy. Finally, over the course of the study period, there were some clinic-wide efforts, beyond the described intervention, to encourage follow-up with the primary care physician following a discharge from the hospital. We are in the process of attempting to better understand those non-study-related initiatives and their impact on our research efforts.

Conclusions

Our initial findings relating to an HIT-based transitional care intervention that included alerts about key therapeutic changes and therapeutic monitoring recommendations in the setting of a large multispecialty group practice suggest that the intervention was not effective in increasing the likelihood of a visit to an outpatient provider within 14 days following discharge from the hospital, enhancing laboratory monitoring in response to alerts relating to high-risk drugs, reducing adverse drug event rates, or reducing rehospitalization and emergency department visit rates.

List of Publications and Products

Journal publications

Tjia J, Field TS, Garber LD, et al. Development and pilot testing of guidelines to monitor high-risk medications in the ambulatory setting. *Am J Manag Care.* Jul 2010;16(7):489-496.

> Objectives: To develop guidelines to monitor high-risk medications and to assess the prevalence of laboratory testing for these medications among a multispecialty group practice.

> Study Design: Safety intervention trial.

> Methods: We developed guidelines for the laboratory monitoring of high-risk medications as part of a patient safety intervention trial. An advisory committee of national experts and local leaders used a 2-round Internet-based Delphi process to select guideline medications based on the importance of monitoring for efficacy, safety, and drug–drug interactions. Test frequency recommendations were developed by academic pharmacists based on a literature review and local interdisciplinary consensus. To estimate the potential effect of the planned intervention, we determined the prevalence of high-risk drug dispensings and laboratory testing for guideline medications between January 1, 2008, and July 31, 2008.

> Results: Consensus on medications to include in the guidelines was achieved in 2 rounds. Final guidelines included 35 drugs or drug classes and 61 laboratory tests. The prevalence of monitoring ranged from less than 50.0% to greater than 90.0%, with infrequently prescribed drugs having a lower prevalence of recommended testing (P <.001 for new dispensings and P <.01 for chronic dispensings, nonparametric test for trend). When more than 1 test was recommended for a selected medication, monitoring within a medication sometimes differed by greater than 50.0%.

> Conclusions: Even among drugs for which there is general consensus that laboratory monitoring is important, the prevalence of monitoring is highly variable. Furthermore, infrequently prescribed medications are at higher risk for poor monitoring.

Tjia J, Fischer SH, Raebel MA, et al. Baseline and follow-up laboratory monitoring of cardiovascular medications. *Ann Pharmacother.* Sep 2011;45(9):1077-1084.

> Background: Laboratory monitoring of medications is typically used to establish safety prior to drug initiation and to detect drug-related injury following initiation. It is unclear whether black box warnings (BBWs) as well as evidence- and consensus-based clinical guidelines increase the likelihood of appropriate monitoring.

> Objective: To determine the proportion of patients newly initiated on selected cardiovascular medications with baseline assessment and follow-up laboratory monitoring and compare the prevalence of laboratory testing for drugs with and without BBWs and guidelines.

Methods: This cross-sectional study included patients aged 18 years or older from a large multispecialty group practice who were prescribed a cardiovascular medication (angiotensin converting enzyme inhibitors, angiotensin II receptor blockers, amiodarone, digoxin, lipid-lowering agents, diuretics, and potassium supplements) between January 1 and July 31, 2008. The primary outcome measure was laboratory test ordering for baseline assessment and follow-up monitoring of newly initiated cardiovascular medications.

Results: The number of new users of each study drug ranged from 49 to 1757 during the study period. Baseline laboratory test ordering across study drugs ranged from 37.4% to 94.8%, and follow-up laboratory test ordering ranged from 20.0% to 77.2%. Laboratory tests for drugs with baseline laboratory assessment recommendations in BBWs were more commonly ordered than for drugs without BBWs (86.4% vs 78.0%, p < 0.001). Drugs with follow-up monitoring recommendations in clinical guidelines had a lower prevalence of monitoring (33.1% vs 50.7%, p < 0.001).

Conclusions: Baseline assessment of cardiovascular medication monitoring is variable. Quality measurement of adherence to BBW recommendations may improve monitoring. Key words: boxed warning, cardiovascular drugs, laboratory monitoring, patient safety, physician behavior, quality of care

Tjia J, Field TS, Fischer SH, et al. Quality measurement of medication monitoring in the "meaningful use" era. *Am J Manag Care*. Sep 2011;17(9):633-637.

Objectives: While the 2011 implementation of "meaningful use" legislation for certified electronic health records (EHRs) promises to change quality reporting by overcoming data capture issues affecting quality measurement, the magnitude of this effect is unclear. We compared the measured quality of laboratory monitoring of Healthcare Effectiveness Data and Information Set (HEDIS) medications based on specifications that (1) include and exclude patients hospitalized in the measurement year and (2) use physician test orders and patient test completion.

Study design: Cross-sectional study.

Methods: Among patients 18 years and older in a large multispecialty group practice utilizing a fully implemented EHR between January 1, 2008, and July 31, 2008, we measured the prevalence of ordering and completion of laboratory tests monitoring HEDIS medications (cardiovascular drugs [angiotensin-converting enzyme inhibitors or angiotensin receptor blockers, digoxin, and diuretics] and anticonvulsants [carbamazepine, phenobarbital, phenytoin, and valproic acid]).

Results: Measures excluding hospitalized patients were not statistically significantly different from measures including hospitalized patients, except for digoxin, but this difference was not clinically significant. The prevalence of appropriate monitoring based on test orders typically captured in the EHR was statistically significantly higher than the prevalence based on claims-based test completions for cardiovascular drugs.

Conclusions: HEDIS quality metrics based on data typically collected from claims undermeasured quality of medication monitoring compared to EHR data. The HEDIS

optional specification excluding hospitalized patients from the monitoring measure does not have a significant impact on reported quality. Integration of EHR data into quality measurement may significantly change some organizations' reported quality of care.

Field TS, Garber L, Gagne SJ, et al. An automated alert system when patients are discharged from hospitals or SNFs. (In Submission).

Objective: To describe the technological resources, expertise and time needed to develop and implement an automated system providing critical information and alerts to primary care physicians when their patients transition from hospitals or skilled nursing facilities to home.

Study Design: Within a large medical group practice with an EMR, we developed and implemented an automated alert system that provides notification of discharges, reminders of the need for follow-up visits, new drugs added during the in-patient stay, warnings about drug-drug interactions, and recommendations for dosing changes and laboratory monitoring of high risk drugs. We tracked components of the information system required to accomplish this as well as the time spent by team members. We used US national averages of relevant hourly wages to estimate personnel costs.

Results: Critical components of the information system are notifications of hospital discharges through an admission, discharge and transfer registration (ADT) interface, linkage to the group practice scheduling system, timely access to information on pharmacy dispensing and lab tests, and an interface engine to direct messages to specific physicians and staff. Total personnel cost was $76,314. Nearly half (47%) was for 614 hours by physicians who developed content, provided overall project management, and reviewed alerts during a test period to ensure that only "actionable" alerts would be sent.

Conclusion: Implementing a system to provide a flow of critical information about patient transitions requires strong internal informatics expertise, cooperation between facilities and ambulatory providers, development of a number of electronic linkages, and extensive commitment of physician time.

Conference presentations and abstracts

Tjia J, Field TS, Garber L, Donovan J, Kanaan A, Fischer SH, Zhao Y, Fuller J, Gurwitz JH. Development and pilot testing of guidelines to monitor high-risk medications in the ambulatory setting and post-hospital discharge. AHRQ Annual Conference. 2009 Sep 13-16; Bethesda, MD.

Background/Purpose: Inadequate laboratory monitoring of high-risk medications contributes to many preventable adverse drug events. One barrier to appropriate monitoring is lack of standardized monitoring guidelines. This report describes the development of guidelines to monitor high risk medications in the ambulatory setting and post-hospital discharge. It also assesses the prevalence of appropriate testing for new and chronic medications based on these guidelines.

Methods: In a multispecialty group practice, we developed guidelines for laboratory monitoring of high-risk medications as part of a patient safety intervention trial to improve drug safety for ambulatory patients using the electronic medical record. We used a modified Delphi process to achieve consensus around selection of medications for monitoring and to determine monitoring frequency among a local and national interdisciplinary group of physicians, pharmacists, pharmacoepidemiologists, and patient safety experts. We then assessed the baseline prevalence of appropriate monitoring by ambulatory physicians for the period from January 1, 2008 to July 31, 2008 for both new and chronic users of high-risk medications.

Results: Consensus on guidelines was achieved in 2 rounds. Final guidelines included 38 drugs and drug classes and a total of 66 laboratory tests. Some medications required more than one laboratory test (e.g.. amiodarone monitoring included AST and TSH). The prevalence of appropriate monitoring ranged from less than 50% to over 90%, with infrequently prescribed drugs having a lower prevalence of appropriate testing. When more than one test was indicated to monitor a medication, the prevalence of monitoring sometimes differed by as much as 50% among tests for the same drug.

Conclusions/Implications: Infrequently prescribed medications are at high risk for poor monitoring.

Tjia J, Field T, Garber L, Raebel M, Donovan L, Kanaan A, Fischer S, Gagne S, Zhao Y, Fuller J, Gurwitz J. Development and pilot testing of guidelines to monitor high-risk medications in the ambulatory setting. 16th Annual HMO Research Network Conference; 2010 Mar 21-24; Austin, Texas.

Background: Inadequate laboratory monitoring of high-risk medications contributes to preventable adverse drug events. One barrier to appropriate monitoring is lack of standardized monitoring guidelines. The study aims were to develop guidelines to monitor high-risk medications and to assess the prevalence of laboratory testing for these medications in a multispecialty group practice.

Study Design/Methods: We developed guidelines for laboratory monitoring of high-risk medications as part of a patient safety intervention trial. An advisory committee of national experts and local leaders (clinicians, pharmacists, pharmacoepidemiologists, and patient safety experts) used a two-round, internet-based Delphi process to select guideline medications based on the importance of monitoring for efficacy, safety, and drugdrug interactions. Test frequency recommendations were developed by academic pharmacists based on literature review and local interdisciplinary consensus. To estimate the potential impact of the intervention, we determined the prevalence of high-risk drug dispensings and laboratory testing for guideline medications between January 1, 2008 and July 31, 2008.

Results: Consensus on medications to include in the guidelines was achieved in two rounds. Final guidelines included 35 drugs/drug classes and 61 laboratory tests. The prevalence of monitoring ranged from <50% to >90%, with infrequently prescribed drugs having a lower prevalence of recommended testing. When more than one test was recommended for a selected medication, monitoring within a medication sometimes differed by >50%.

Conclusions: Even among drugs where there is general consensus that laboratory monitoring is important, prevalence of monitoring is highly variable. Further, infrequently prescribed medications are at higher risk for poor monitoring.

Fischer SH, Tjia J, Field TS, Raebel MA, Zhao Y, Garber L, Donovan J, Kanaan A, Gagne SJ, Gurwitz JH. Understanding laboratory monitoring of high-risk cardiovascular drugs: identifying the relative contribution of physician and patient adherence to monitoring measurements. AHRQ Annual Health IT Grantee and Contractor Meeting. 2010 Jun 2-4; Washington, DC.

Background:
Monitoring errors contribute to preventable drug injuries, but lab monitoring of high-risk medications is low. It is unclear whether low monitoring is due to physician test ordering behavior or non-adherence to ordered tests by patients. This study examines: 1) completion of recommended monitoring tests; 2) incomplete testing attributable to lack of physician test ordering; and 3) incomplete testing attributable to patient non-adherence to ordered tests.

Methods and Results:
We measured ordering and completion of laboratory tests for high-risk cardiovascular medications used in the ambulatory setting (ACE inhibitors, ARBs, amiodarone, digoxin, lipid-lowering medications, diuretics, and potassium supplements) in a large multispecialty group practice between January 1, 2008 and July 31, 2008. The prevalence of recommended test completion for cardiovascular medications ranged from ~30% to >95%. For all drugs, the proportion of recommended tests not ordered by clinicians ranged from 5%- 60%; the proportion of ordered tests not completed by the patient ranged from 5%-18%.

Conclusions/Implications:
Completion of recommended laboratory monitoring tests for high-risk cardiovascular medications varied between drugs. Physician ordering behavior exhibited more variation than patient adherence to test ordering. HIT interventions to improve monitoring of high-risk medications could target both physicians and patients.

Tjia J, Field T, Raebel M, et al. PS1-40: Laboratory Monitoring of HEDIS Medications in the Ambulatory Setting: The Relative Contribution of Physician and Patient Behavior to Undermonitoring. 17th Annual HMO Research Network Conference; 2011 Mar 23-25; Boston, Massachusetts. *Clin Med Res.* Nov 2011;9(3-4):178-179.

Background/Aims: Initiative to improve the quality and safety of pharmaceutical care have lead to the development of quality of care measures including standards for the appropriate monitoring of high-risk medications (defined as medications commonly implicated in adverse drug events or with narrow therapeutic window). While low rates of laboratory monitoring of high-risk medications might indicate poor physician performance, it is unclear how much patient non-adherence to physician-ordered tests contribute to undermesruement of physician quality. The study aim is to determine, for Health Employer Data Information Set (HEDIS) quality of care, high-risk medication laboratory monitoring measures: the prevalence of completion of recommended

monitoring tests; and the proportion of incomplete testing attributable to lack of clinician test ordering relative to patient non-adherence to ordered tests.

Methods and Results: We measured the ordering and completion of laboratory tests for HEDIS-based high-risk medications (ACE inhibitors, ARBs, digoxin and diuretics, and anticonvulsants) in a large multispecialty group practice between January 1, 2008 and July 31, 2008. Laboratory test completion for HEDIS cardiovascular drugs was higher than for anticonvulsants. Each cardiovascular drug had a completion rate of > 85%, while the completion rate for anticonvulsants ranged from 30-75%. The lowest test completion rate was for phenobarbital levels to monitor phenobarbital (30%). For all cardiovascular and anticonvulsant drugs, the proportion of recommended tests not ordered by the clinician ranged from 5% to 60%. The lowest test order prevalence was for phenobarbital level for phenobarbital use (35%), followed by valproic acid level for valproate use(48%), and carbamazepine level for carbamazepine use (60%). Rates of patient noncompletion of ordered tests for all drugs was generally <10%.

Conclusion: Completion of laboratory monitoring tests for high-risk cardiovascular medications was higher than for high-risk anticonvulsants according to HEDIS guidelines. Clinician ordering behavior exhibited more variation than patient adherence to test orders. Underestimation of HEDIS quality of care monitoring due to patient non-adherence is minimal for cardiovascular medications, but higher for anticonvulsants.

Field T. Estimating the ROI for computerized clinical decision support systems: pieces of the puzzle. Track F: Economic Analysis of Health IT. AHRQ 2011 Annual Conference; 2011 Sep 18-21; Bethesda, MD.

Webinar presentations

Gurwitz JH, Field TS. Potential of health it for prescribing and monitoring medication for older adults. National Web-Based Teleconference on Utilizing Health IT to Improve Medication Management for the Care of Elderly Patients. 2011 Aug 18. Agency for Healthcare Research and Quality. 2011 Nov. http://healthit.ahrq.gov/portal/server.pt/document/955352/accessible%2Baugust%2Bnational%2Bweb-based%2Bteleconference_pdf

Garber L. Achieving a higher level of patient safety with electronic health records and health information exchanges. National Patient Safety Foundation Webinar. 2010 Jul 28. National Patient Safety Foundation. 2010. http://npsf.org/members/standup/downloads/National_Patient_Safety_Foundation_Webinar_Larry_Garber.pdf

Field T. Transitions in care. Managing Patient Care Transitions: How Health IT Can Reduce Unnecessary Re-Hospitalization. A National Web Conference on Transitions in Care. 2010 Feb 24. AHRQ National Resource Center for Health Information Technology. 2011 Nov. http://healthit.ahrq.gov/portal/server.pt/gateway/PTARGS_0_3882_912257_0_0_18/2010-02-24%20Transitions%20In%20Care.pdf.

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