1. TITLE PAGE

Final Progress Report

Dissemination of the PPRNet Model for Improving Medication Safety

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2. STRUCTURED ABSTRACT

Purpose and Scope: Improving medication safety (MS) is a fundamental priority for transforming the US healthcare system. An understanding of how to best implement safe practices beyond the inpatient setting is needed. The goal of the project was to decrease preventable prescribing and monitoring medication errors in primary care practices through dissemination of an MS quality improvement model. The MS indicator set and improvement model were developed in PPRNet during an earlier AHRQ-funded project. PPRNet is a national primary care practice-based research network of practices that use a common EHR. *Methods:* Fifty-nine PPRNet practices representing 369 providers from 30 US states volunteered to participate. All practices participated in a project introduction and received quarterly audit and feedback reports on MS indicators. The MS improvement model was disseminated through webinars, network meetings, and site visits. The primary outcome was the change in practice performance on MS indicators over time. Guided by the RE-AIM framework, model implementation was assessed through practice liaison surveys and analysis of project field notes. *Results:* Practices received a median of seven quarterly reports. A majority participated in at least one dissemination activity. Modest improvements in practice performance were observed over time. Participants reported consistent implementation of a number of MS strategies. Strategies to prompt patients to bring medications to visits and use of MS reports to develop tracking systems were new to many practices. Project findings have been disseminated to PPRNet members through ongoing network activities, and relevant MS indicators have been added to PPRNet reports.

Key Words: medication safety, quality of care, practice-based research network, electronic health records

3. PURPOSE

The objectives of this study were to:

1)   Disseminate the PPRNet-Medication Safety (PPRNet-MS) quality improvement model to 60 PPRNet practices;

2)   Assess the impact of PPRNet-MS implementation on practice adherence with medication safety indicators over time; and

3)   Develop and disseminate a medication safety toolkit and implementation guide.

4. SCOPE

Background

Improving medication safety (MS) is a fundamental priority for transforming the US healthcare system. Preventable medication errors continue to cause harm in the outpatient setting. Few improvement strategies have been tested in primary care, and an understanding of how to best disseminate and implement safe practices beyond the inpatient setting is needed.

Context

In an earlier AHRQ-funded demonstration project,[1-3] the PPRNet research team developed an MS indicator set and improvement model relevant to primary care practice. Using ambulatory care electronic health record (EHR) data, the indicator set assesses practice performance in five categories of MS: avoiding potentially inappropriate therapy, dosages, drug-drug interactions, drug-disease interactions, and monitoring of potential adverse events. The MS practice improvement model incorporates elements of safety culture, team-based safe practice strategies, use of EHR-enabled decision support tools, and feedback on preventable errors.

5. METHODS

Fifty-nine practices with 369 providers from 30 states volunteered to participate in this multi-method dissemination project. All practices participated in a project introduction and received quarterly practice and patient-level audit and feedback reports on the MS indicator set. The MS improvement model was disseminated through webinars, network meetings, and practice site visits.

The primary outcome was the change in practice performance on MS indicators examined using generalized linear mixed models, which account for repeat measurements on practices over time. Each practice's baseline was defined as the month of project introduction participation. Practices were excluded from the quantitative analysis if they installed their EHR on or after October 1, 2009, due to concerns for incomplete or inconsistent recording of medications,

problems, or laboratory data. Qualitative analysis of MS model implementation was guided by the RE-AIM (Reach, Effectiveness, Adoption, Implementation, Maintenance) framework.

Data Sources

Change in practice performance on the MS indicator set was analyzed using data from routine practice EHR data extracts. Model implementation data sources included baseline and final practice liaison surveys as well as field notes from project network meetings and site visits.

Measures

The PPRNet MS indicator set is presented in Table 1. The primary quantitative outcome will be presented by MS indicator category. Based on qualitative feedback from PPRNet practices and updated recommendations on warfarin monitoring,[4] three modifications were made to the indicator set at the beginning of this project. Two drug-drug interaction indicators (ACE inhibitors or ARBs with potassium-sparing diuretics in elderly patients or patients with decreased renal function) were removed, and the international normalized ratio (INR) monitoring frequency for warfarin was extended from 30 days to 45 days.

Table 1: PPRNet Medication Safety Indicator Set[2]

Avoiding Potentially Inappropriate Therapy
- Antibiotics in upper respiratory infection
- Potentially inappropriate medications in the elderly
- Rarely appropriate medications in the elderly

Avoiding Potentially Inappropriate Dosing
- Allopurinol based on renal function
- Short-acting benzodiazepines in the elderly
- Digoxin in the elderly with CHF
- H2 blockers based on renal function

Avoiding Potential Drug-Drug Interactions
- Macrolide antibiotics and digoxin
- Tetracycline and digoxin
- Itraconazole and statin
- Lithium and thiazide diuretic
- Methotrexate and trimethoprim
- Sulfonylurea and sulfamethoxazole in the elderly

Avoiding Potential Drug-Disease Interactions
- Anticholinergics in dementia
- Bupropion in epilepsy
- Metformin in renal impairment
- Metoclopramide in Parkinson's disease
- NSAID or COX2 inhibitor in CHF, HTN, or GFR <20 mL/min
- NSAID in peptic ulcer disease
- Thiazolidinediones in CHF

Monitoring of Potential Adverse Drug Events
• Annual serum creatinine for ACE inhibitor, ARB, digoxin, diuretics, metformin, NSAID, COX2 inhibitor
• Annual potassium for ACE inhibitor, ARB, digoxin, diuretics
• Serum creatinine, potassium in 6 months for (ACE inhibitor or ARB) and K-sparing diuretic
• Potassium >3.5 mEq/L for thiazide diuretics
• Annual hemoglobin, platelet count for antiplatelets and anticoagulants
• Annual glucose, weight for antipsychotics
• INR in the past 45 days for warfarin, most recent INRs <5
• Folic acid supplementation for methotrexate

6. RESULTS

Participating practices received a median of seven quarterly reports (range, 1-8) from October 1, 2010, to July 1, 2012. A majority of practices attended at least one webinar (56%, n=33) or sent representatives to network meetings (63%, n=37). Fifteen practices (25%) hosted an onsite visit. Using the exclusion criteria defined above, 55 practices (93%) were eligible for quantitative analysis. Findings from these analyses are shown in Figure 1. Significant changes were noted in three indicator categories using generalized linear mixed model analyses, which account for repeat measurements on practices over time. Modest improvements were observed in avoiding potentially inappropriate dosing and drug-disease interactions and monitoring of potential adverse drug events. Quantitative results are limited by a smaller sample of practices with 18 months of study data.

Results from the practice survey on implementation of the MS improvement model are shown in Figure 2. After the first year of the project, two new strategies were incorporated into the improvement model from qualitative findings and were presented to participants in the final implementation survey. The revised MS improvement model is presented in Table 2; general strategies are followed by more specific practice-based strategies. In the overarching concept of assuring the accuracy of the recorded medication list, participating practices described new approaches for patients to bring in their medications for review during clinic visits. Some clinics distributed medication bags with practice logos as a visual reminder and used this improvement activity as a case example for patient-centered medical home initiatives. In the category of using MS reports to evaluate performance over time, practices reported using these reports specifically to develop tracking systems for patients on warfarin. As practices reviewed their reports during webinars, network meetings, or site visits, they recognized the lack of tracking no shows or patients seen by outside providers/laboratories as an opportunity for improvement.

Respondents reported consistent implementation of a number of MS strategies; findings are limited by a low response rate. *How* practices implemented these strategies was a focus of site visit and webinar activities as well as "best practice" panel discussions at the 2012 network meeting. Project participants highlighted approaches to prompt patients to bring medications to visits (consistent messages during every type of patient interaction and distribution of

medication "bags"), how team care improves consistency of medication reconciliation, and how calls/requests for medication refills provide an opportunity to activate patients. Additionally, participants shared specific examples of how they integrated use of MS reports as a means of proactive population management and patient outreach.

The "PPRNet Medication Safety Toolkit" was developed as Aim 3 of this project and was refined and disseminated during the final year of the project. It is currently hosted on the PPRNet webpage at: http://academicdepartments.musc.edu/PPRNet/research/mstrip2home. It includes links to academic detailing materials on the MS indicator set and MS improvement model. The largest portion of the toolkit contains links to practice-based tools, arranged by category of MS improvement strategies: developing a practice culture of medication safety, assuring accurate medication lists, and implementing refill protocols. The general strategies, practice tools, and implementation tips, though developed by a group of practices that use a common EHR, are expected to be relevant to most primary care practices.

Discussion

The goal of disseminating MS reports and the MS improvement model to 60 practices across the United States was achieved. A modest impact was observed on practice-level preventable prescribing and monitoring error indicators over time. The MS improvement model strategies resonated with this larger group of practices. Practice-based medication reconciliation strategies and approaches to monitoring of high-risk medications through use of MS reports were added to the refined MS improvement model. Additional research on what dissemination approaches work best for individual practices and on specific safety or quality innovations is warranted.

**Figure 1: Practice Performance on Medication Safety Indicators Over Time[5]**
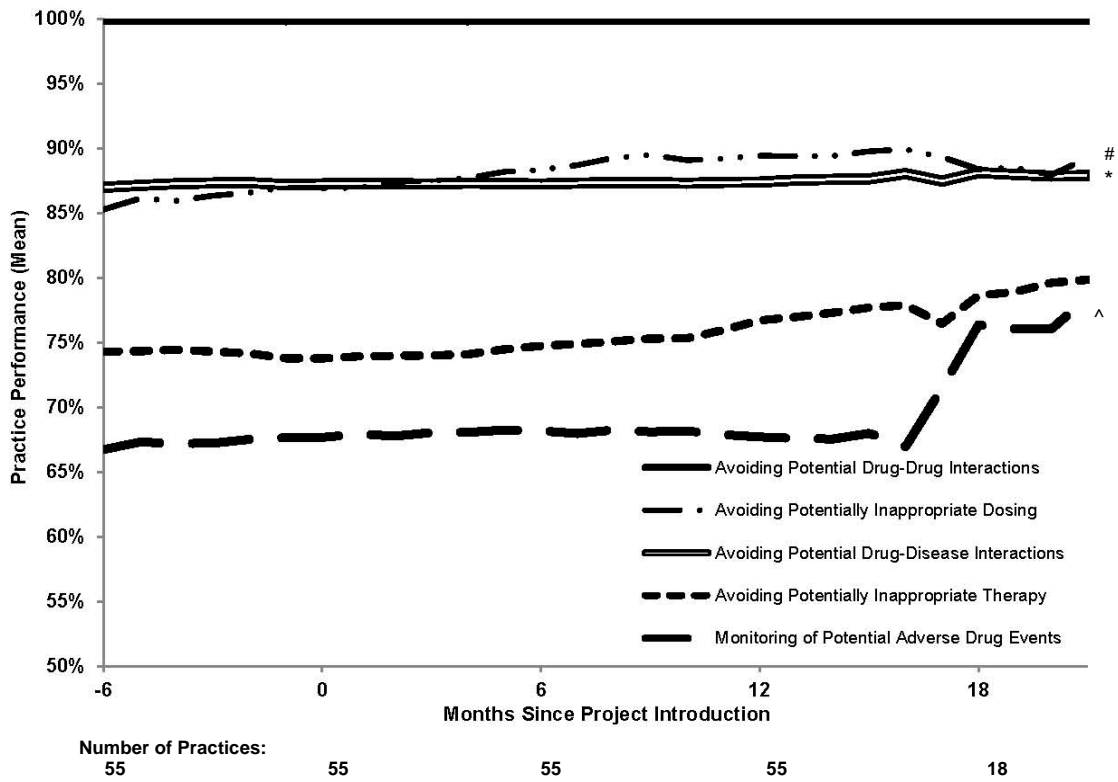
18-month estimated change: #2.7%, p=0.02; *0.9%, p=0.02; ^4.9%, p<0.0001.

Table 2: PPRNet Medication Safety Improvement Model

Disseminate evidence on the problem of medication safety in primary care in order to develop a local practice culture that prioritizes safe prescribing and practice evaluation
- Develop a practice-level understanding of the prevalence and consequences of preventable medication errors
- Deliver medication safety education and reminders to patients consistently across the practice
- Utilize medication safety practice performance reports to evaluate performance over time and guide improvement plans

Ensure the accuracy of each patient's recorded medication list
- Document all medications prescribed by practice providers on the medication list
- Implement process for patient review and update with specific inquiry for nonprescription therapy and medications from outside providers
- Ask patients to bring in medications for review
- Distribute or electronically share updated medication list at the end of each visit

Integrate EMR decision support features into routine practice
- Utilize tool to calculate doses for renally adjusted medications based on creatinine clearance
- Apply medication monitoring protocols

Implement a practice protocol for medication refills that incorporates principles of safe use and appropriate monitoring
- Educate staff on refill protocol and use of EMR decision support
- Schedule refills according to medication monitoring requirements
- Empower staff to review monitoring prompts and implement standing orders

Design and execute case management for patients who meet criteria for preventable prescribing and monitoring errors
- Use patient-level reports to identify patients
    o Determine appropriate plan for individual patients or by medication safety category
        ▪ Notify providers about patients who meet criteria
        ▪ Highlight potential preventable errors in EMR
        ▪ Contact patients with medication adjustments or monitoring instructions
    o Develop tracking system for patients on warfarin

Figure 2: Results - Implementation of Medication Safety Improvement Model (n=29 practice responses)

*Added to survey from preliminary qualitative analyses
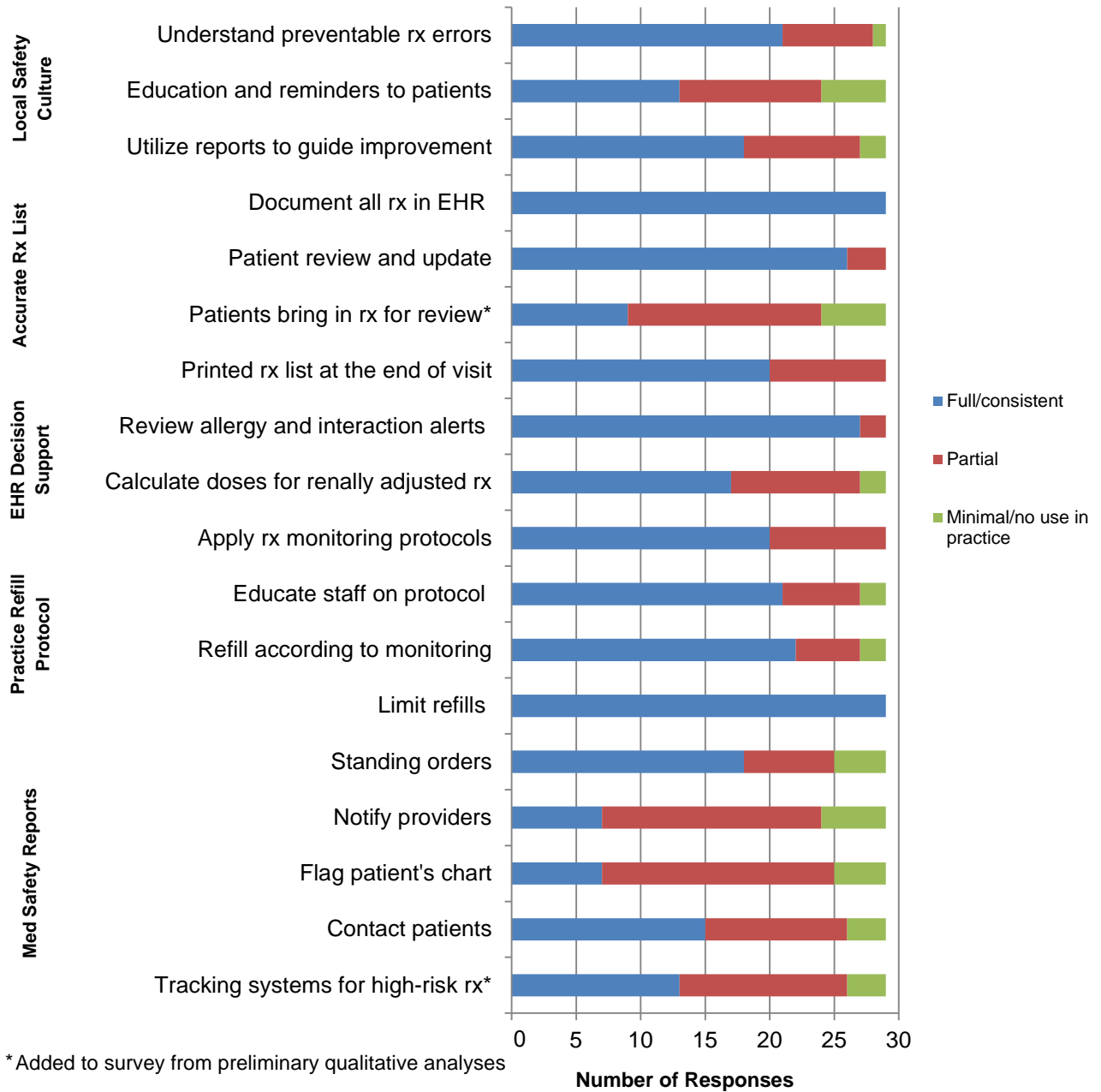
Implications

Although only modest quantitative changes were observed, lessons from this dissemination project on use of a broad MS indicator set and implementation MS improvement strategies are relevant to the growing number of US primary care practices that will adopt and "meaningfully use" EHRs. As the MS knowledge base evolves, implementation research will be needed in the future to guide the design of relevant, effective interventions in order to realize national patient safety improvement goals.

MS indicators from this project have been supplemented with MS-related EHR Meaningful Use Clinical Quality Measures and added to PPRNet reports. The current set of MS indicators is displayed in Figure 3. Practices received feedback on the practice, provider, and patient levels. The patient-level report displays lists of patients that *do not* meet indicator criteria, or those patients who may be at risk for potential medication prescribing or monitoring errors. These reports are regularly disseminated to over 150 member practices in 40 US states. The MS toolkit and findings from this project will continue to be integrated into PPRNet learning network activities as an AHRQ Center for Primary Care Practice-Based Research and Learning.

Figure 3: PPRNet Medication Safety Quality Indicators (as of December 30, 2013)

Medication Safety
51. Avoiding potentially inappropriate medications in patients ≥ 66 years
52. Appropriate dosages of Benzodiazepines in patients ≥ 65 years
53. Appropriate dosages of H2 blockers in patients with CrCl < 50 ml/min
54. Avoid Rx of anticholinergic in patients with Dx of dementia
55. Avoid Rx for NSAID or Cox 2 Inhibitor in patients with Dx of Heart Failure
56. Cautious use of NSAID or Cox 2 Inhibitor in patients with Dx of Hypertension
57. Avoid Rx for Thiazolidinedione in patients with Dx of Heart Failure
58. Avoid Rx for Metformin in patients with most recent Serum Creatinine in past year (men with SCr >= 1.5 mg/dl and women with SCr >= 1.4 mg/dl)
59. Serum creatinine measured in past year in patients with Rx for any ACE Inhibitor or A II Inhibitor, Digoxin, any diuretic, or Metformin
60. Serum creatinine measured in past six months in either (patients ≥ 65 years or with CrCl < 50 ml/min) and Rx for (ACE Inhibitor or A II Inhibitor) and K Sparing diuretic
61. Most recent Potassium measurement ≥ 3.5 meq/L in patients with Rx for any thiazide and Potassium measure in past year
62. Hemoglobin measured in past year in patients with Rx for any Anti-Platelet (excluding Aspirin) or Oral Anticoagulant
63. Glucose measured in past year in patients with Rx for any Antipsychotic
64. Patients with active Rx for Warfarin with INR measured in past 45 days
65. Patients with Dx of A-fib and Warfarin Rx with INR within the therapeutic range

7. LIST OF PUBLICATIONS AND PRODUCTS

The PPRNet Medication Safety Toolkit is hosted on the PPRNet webpage at http://academicdepartments.musc.edu/PPRNet/research/mstrip2home. A poster on preliminary findings was presented at the 2012 Annual Meeting of the North American Primary Care Research Group (NAPCRG).[5] The final summary manuscript is in development and will be submitted to *BMC Health Services Research*. A manuscript on the implementation of MS strategies and the refined MS improvement model is also in development, with a planned submission to *BMC Medical Informatics and Decision Making.*

References

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