



# AHRQ Health Information Technology Ambulatory Safety and Quality

Findings and Lessons  
From the Enabling Quality  
Measurement Through  
Health IT Grant Initiative



Agency for Healthcare Research and Quality  
Advancing Excellence in Health Care • [www.ahrq.gov](http://www.ahrq.gov)

HEALTH IT



This document is in the public domain and may be used and reprinted without permission except those copyrighted materials that are clearly noted in the document. Further reproduction of those copyrighted materials is prohibited without the specific permission of copyright holders.

Suggested Citation:

Findings and Lessons From the Enabling Quality Measurement Through Health IT Grant Initiative. (Prepared by Westat, under Contract No. HHSA 2902009000231.) AHRQ Publication No. 12-0047-EF. Rockville, MD: Agency for Healthcare Research and Quality. May 2012.

Prepared for:

Agency for Healthcare Research and Quality  
U.S. Department of Health and Human Services  
540 Gaither Road  
Rockville, MD 20850  
[www.ahrq.gov](http://www.ahrq.gov)

**Contract No. HHSA 2902009000231**

Prepared by:

Westat  
Russell Mardon, Ph.D., Project Director

AHRQ Publication No. 12-0047-EF  
May 2012

This project was funded by the Agency for Healthcare Research and Quality (AHRQ), U.S. Department of Health and Human Services. The opinions expressed in this document are those of the authors and do not reflect the official position of AHRQ or the U.S. Department of Health and Human Services.

## Preface

The Enabling Patient-Centered Care Through Health IT initiative is part of the Agency for Healthcare Research and Quality's (AHRQ's) Ambulatory Safety and Quality (ASQ) program. The purpose of the AHRQ ASQ program is to improve the safety and quality of ambulatory health care in the United States. The program's components, with the exception of the risk assessment grant initiative (FOA HS-07-003), emphasize the role of health information technology (IT). The ASQ program included the following grant initiatives:

- Enabling Quality Measurement Through Health IT (FOA HS-07-002), which focused on strategies for the development of health IT to assist clinicians, practices, and systems to measure the quality and safety of care in ambulatory care settings.
- Ambulatory Care Patient Safety Proactive Risk Assessment (FOA HS-07-003), which supported research in risk assessment and modeling to identify preventable patient injuries and harms and to inform the development and deployment of intervention strategies to reduce threats to patient safety in ambulatory care settings and during transitions of care.
- Improving Quality Through Clinician Use of Health IT (FOA HS-07-006), which supported research related to the development, implementation, and use of health IT to assist clinicians, practices, and systems in improving the quality and safety of care delivery in ambulatory care settings.
- Enabling Patient-Centered Care Through Health IT (FOA HS-07-007), which was designed to investigate approaches to improve the patient experience of care through the use of health IT in ambulatory care settings.
- Improving Management of Individuals With Complex Healthcare Needs Through Health IT (FOA HS-08-002), which was aimed at clinician and patient and family use of health IT in ambulatory settings to improve outcomes through more effective decision support or care delivery for patients with complex health care needs.

This is one in a series of five reports highlighting findings and lessons from the health IT-focused ASQ grant initiatives. These reports summarize the projects in each initiative and identify practical insights regarding the use of health IT to improve safety and quality in ambulatory settings.

## Acknowledgments

This report was developed through a collaborative process that would not have been possible without the contributions of many individuals. We would especially like to thank the following key participants who contributed to and guided the work:

- The EQM grantees, whose work in advancing the use of health IT for quality and safety measurement and feedback inspired and informed the synthesis report.
- Rebecca Roper, M.S., M.P.H., AHRQ program officer and senior research scientist whose feedback and guidance shaped the report.
- External reviewers Sarah Scholle, Dr.P.H., vice president for research at the National Committee for Quality Assurance, and Peter Elkin, M.D., for their insightful feedback and comments.
- The Synthesis Team, a group of Westat senior staff including Ernest Carter, M.D., Ph.D.; Brenda Leath, M.H.S.A.; Russell Mardon, Ph.D.; Eric Pan, M.D.; Jonathan Ratner, Ph.D.; Helga Rippen, M.D., Ph.D.; Elaine Swift, Ph.D.; and Larry Stepnick, M.B.A., of The Severyn Group.
- Other Westat project staff including Julie Bergmann, M.H.S.; Nathan Botts, Ph.D.; Lauren Mercincavage, M.H.S.; and Jennifer Pancholi, M.P.H., M.A.

## Table of Contents

Executive Summary .....	1
Introduction .....	3
Synthesis Methodology .....	5
Developing New Measures .....	6
Background .....	6
Highlights From the Grants .....	6
Accuracy of Measurement .....	8
Background .....	8
Highlights From the Grants .....	8
Risk Adjustment .....	10
Capturing and Integrating Data .....	11
Background .....	11
Innovative Strategies for Data Capture & Extraction .....	11
Strategies To Capture Structured Data .....	11
Strategies To Extract Unstructured Data .....	12
Innovative Strategies for Integrating Data From Multiple Sites and Sources .....	13
Feedback to Clinicians .....	15
Background .....	15
Highlights From the Grants .....	15
Efficiency of Measurement .....	17
Conclusion .....	18

## Table

EQM Grantees .....	2
--------------------	---

## Figures

2A Number of EQM Grantees by Type of Ambulatory Care Setting.....	4
2B Number of EQM Grantees by IOM Priority Area .....	4

## Executive Summary

This report, along with a series of video and written stories, highlights key findings and lessons learned from the experiences of 17 organizations that received grant funding from the Agency for Healthcare Research and Quality (AHRQ) Enabling Quality Measurement (EQM) Through Health IT initiative (2007-2011). The Funding Opportunity Announcement (FOA) FOA-HS-07-002 can be found at <http://grants.nih.gov/grants/guide/rfa-files/RFA-HS-07-002.html>. Each of these grantees pursued innovative approaches toward generating insights on how to use health information technology (health IT) to implement quality measurement activities. The EQM initiative sought to fund 2- to 3-year projects that could produce and disseminate research results rapidly. The relevance of the findings and importance of practical lessons learned by these grantees are amplified by the 2010 passage of the Health Information Technology for Economic and Clinical Health (HITECH) Act, which supports more widespread use of electronic health records (EHRs) for quality measurement and other essential aspects of health care delivery.

The goals of this report were to (1) summarize the extent to which these grantees addressed the areas of interest of the EQM FOA and (2) identify practical insights regarding the use of electronic clinical information systems such as EHRs to implement EHR-derived versions of existing quality measures or to develop new quality measures which had previously not been feasible. This report presents illustrative EQM grantee initial findings in an effort to inform research discussion and to provide guidance to other entities implementing health IT systems for quality measurement and improvement. As grantees continue to disseminate evaluations of these projects, more findings may be demonstrated.

The grantee findings are organized around five of the FOA objectives related to the use of health IT for quality measurement. They are as follows:

1. Developing New Measures - Using EHRs to develop new quality and safety measures, addressed in **five grants**.
2. Accuracy of Measurement - Testing the accuracy of data from EHRs for quality and safety measurement, addressed in **10 grants**.
3. Capturing and Integrating Data - Determining approaches for data capture, extraction, and integration, addressed in **12 grants**.

4. Feedback to Clinicians - Supporting practice-based demonstrations of feedback to clinicians to improve quality, addressed in **six grants**.
5. Efficiency of Measurement - Assessing the efficiency of quality and safety measurement, addressed in **three grants**.

The names of the principal investigators, their institutions, and the grant titles are shown in Table 1, along with links to additional information about the projects on the AHRQ National Resource Center for Health IT Web site [healthit.ahrq.gov/portfolio](http://healthit.ahrq.gov/portfolio).

TABLE

1

**EQM Grantees**

Select Grant Title to see the grant final report or icons for video or written Success Stories

Principal Investigator (PI)*	Institution	Grant Title	EQM FOA Objectives
Kilbridge, Peter and Bailey, Thomas	Washington University	<a href="#">Surveillance for Adverse Drug Events in Ambulatory Pediatrics</a>	Accuracy of Measurement Capturing and Integrating Data, Efficiency of Measurement
Berner, Eta	University of Alabama at Birmingham	<a href="#">Closing the Feedback Loop to Improve Diagnostic Quality</a>	Developing New Measures, Feedback to Clinicians
Davidson, Arthur	Denver Health and Hospital Authority	<a href="#">Colorado Associated Community Health Information Exchange</a>	Capturing and Integrating Data, Feedback to Clinicians
Hazlehurst, Brian	Kaiser Foundation Research Institute	<a href="#">Automating Assessment of Asthma Care Quality</a>	Accuracy of Measurement, Capturing and Integrating Data
Kaushal, Rainu	Weill Medical College of Cornell University	<a href="#">Developing and Using Valid Clinical Quality Metrics for HIT with HIE</a>	Developing New Measures, Accuracy of Measurement
Kmetik, Karen	American Medical Association	<a href="#">Cardio-Hit Phase II</a>	Accuracy of Measurement
Lazarus, Ross	Harvard Pilgrim Health Care	<a href="#">Electronic Support for Public Health - Vaccine Adverse Event Reporting System</a>	Capturing and Integrating Data, Efficiency of Measurement
Lehmann, Christoph	Johns Hopkins University	<a href="#">Medication Monitoring for Vulnerable Populations via IT</a>	Accuracy of Measurement, Capturing and Integrating Data, Feedback to Clinicians
Logan, Judith	Oregon Health & Science University	<a href="#">Improving Quality In Cancer Screening: The Excellence Report For Colonoscopy</a>	Capturing and Integrating Data, Feedback to Clinicians
McColm, Denni	Citizens Memorial Hospital District	<a href="#">Standardization and Automatic Extraction of Quality Measures in an Ambulatory EHR</a>	Accuracy of Measurement, Capturing and Integrating Data
Schneider, Eric	Harvard University	<a href="#">Massachusetts Quality E-Measure Validation Study</a>	Capturing and Integrating Data
Selby, Joe	Kaiser Foundation Research Institute	<a href="#">Feedback of Treatment Intensification Data to Reduce Cardiovascular Disease Risk</a>	Feedback to Clinicians
Thomas, Eric	University of Texas Health Science Center	<a href="#">Using Electronic Records to Detect and Learn from Ambulatory Diagnostic Errors</a>	Developing New Measures, Accuracy of Measurement, Efficiency of Measurement
Turchin, Alexander	Brigham and Women's Hospital	<a href="#">Monitoring Intensification of Treatment for Hyperglycemia and Hyperlipidemia</a>	Developing New Measures, Accuracy of Measurement,
Weiner, Mark	University of Pennsylvania	<a href="#">Crossing the Quality Assessment Chasm: Aligning Measured and True Quality of Care</a>	Accuracy of Measurement, Capturing and Integrating Data
Vogt, Thomas and Williams, Andrew	Kaiser Foundation Research Institute	<a href="#">Using IT to Improve the Quality of CVD Prevention &amp; Management</a>	Developing New Measures, Capturing and Integrating Data
Mostashari, Farzad and Wu, Winfred	NYC Department of Health/Mental Hygiene	<a href="#">Bringing Measurement to the Point of Care</a>	Accuracy of Measurement, Capturing and Integrating Data, Feedback to Clinicians



\* For grants with two PIs listed, the first one was PI at the beginning of the project, the second one at the end of the project.

## Introduction

This report, along with a series of video and written stories, highlights key findings and lessons from the experiences of 17 organizations that received grant funding from the Agency for Healthcare Research and Quality (AHRQ) Enabling Quality Measurement (EQM) Through Health IT initiative, (2007-2011). The Funding Opportunity Announcement (FOA) FOA-HS-07-002 can be found at <http://grants.nih.gov/grants/guide/rfa-files/RFA-HS-07-002.html>. It is part of AHRQ's Ambulatory Safety and Quality (ASQ) program, which was designed to improve the safety and quality of ambulatory health care in the United States. Each of these grantees pursued innovative approaches toward generating insights on how to use health information technology (health IT) to implement quality measurement activities. The EQM initiative sought to fund 2- to 3-year projects that could produce and disseminate research results rapidly. The relevance of the findings and importance of practical lessons learned by these grantees are amplified by the 2010 passage of the Health Information Technology for Economic and Clinical Health (HITECH) Act, which supports more widespread use of electronic health records (EHRs) for quality measurement and other essential aspects of health care delivery. The names of the principal investigators of the EQM grants, their institutions, the grant titles, and the EQM objectives addressed by each grant are provided in the Executive Summary, along with links to additional information about the projects on the AHRQ National Resource Center for Health IT Web site [healthit.ahrq.gov/portfolio](http://healthit.ahrq.gov/portfolio).

Grants were expected to focus on at least one of the Institute of Medicine (IOM) priority areas for health care quality improvement (<http://www.ahrq.gov/qual/iompriorities.htm>). In addition, the applicants were to focus on advancing quality and safety measurement through the use of health IT by addressing at least one of the following objectives:

- Developing new safety and quality measures for ambulatory care settings.
- Assessing the accuracy of quality measurement, with an emphasis on the role of EHRs.
- Determining data elements and strategies for capturing and integrating data for ambulatory safety and quality measurement.
- Supporting practice-based demonstrations of the feedback of electronic quality and safety measures to clinicians and practices to improve care.
- Measuring the efficiency of the routine measurement of ambulatory quality and safety through the use of electronic health information systems.
- Demonstrating the ability of interoperable electronic data systems to provide data for measures of quality and safety of care for episodes of care across settings.

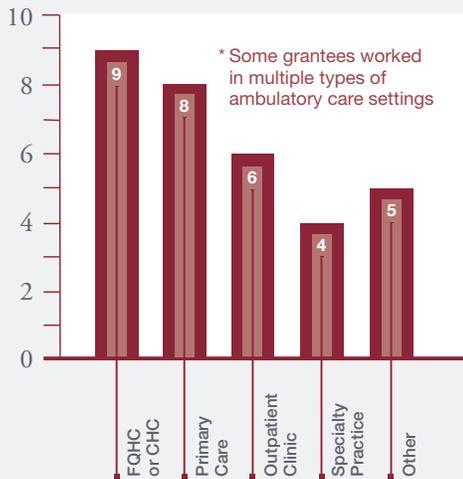
- Demonstrating health information exchange (HIE) as means of supplying data for, and public reporting of, patient safety and quality measures and emerging transparency initiatives.

The goals of this report were to (1) summarize the extent to which these grantees addressed the areas of interest of the EQM FOA and (2) identify practical insights regarding the use of electronic clinical information systems such as EHRs to implement EHR-derived versions of existing quality measures or to develop new quality measures which had previously not been feasible. An EHR is defined as an electronic record of health-related information on an individual that conforms to nationally recognized interoperability standards and that can be created, managed, and consulted by authorized clinicians and staff across more than one health care organization. This report presents illustrative EQM grantee initial findings in an effort to inform research discussion and to provide guidance to other entities implementing health IT systems for quality measurement and improvement. As grantees continue to disseminate evaluations of these projects, more findings may be demonstrated. The grantees' findings are organized around the first five of the FOA objectives relating to electronically enabled quality measurement. The last two of the EQM objectives listed above were not substantively addressed by the EQM grantees.

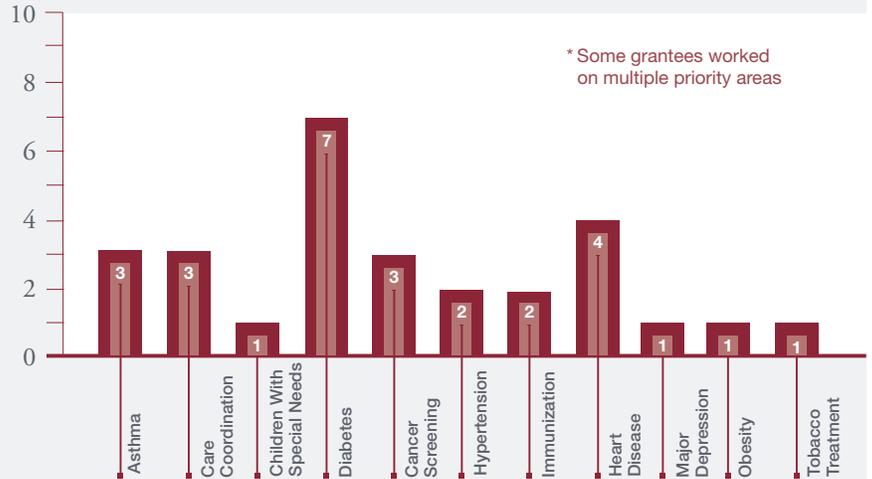
The grantees began work on these projects in 2007, well before the enactment of the HITECH Act, which has focused national attention and funding on the meaningful use of EHRs and other types of health IT for quality measurement and other essential aspects of health care delivery. All of these grantees were early users of EHRs and used that experience as a foundation for their research. The work of these grantees has become even more relevant since the passage of HITECH and the more widespread use of EHRs, as the importance of generating clinically informed electronic quality measures is more widely recognized and pursued.

As shown in Figure 2A, the grants were carried out in a variety of ambulatory care settings, including primary care offices, outpatient clinics, Federally Qualified Health Centers (FQHCs) or Community Health Centers (CHCs), and specialty care offices. They addressed a range of care processes, including several IOM priority areas such as chronic disease management (e.g., asthma, diabetes, or heart disease), care coordination, and immunization as shown in Figure 2B. Each grantee addressed at least one IOM priority area.

**FIG. 2A** Number\* of EQM Grantees by Type of Ambulatory Care Setting



**FIG. 2B** Number\* of EQM Grantees by IOM Priority Area



## Synthesis Methodology

The goal of the grant synthesis was to identify the extent to which the EQM grantees addressed the objectives of the FOA and to highlight preliminary illustrative lessons from their experiences based on their final grant reports and early manuscripts, which represent a snapshot of their accomplishments. Many grantees will continue to garner insight about these projects through subsequent analyses and dissemination of those findings through peer-reviewed manuscripts and public presentations. The synthesis team did not evaluate each grant individually and did not attempt a meta-analysis of the grant results, as the aims and results of the grants were highly variable. Instead, the team used an approach that included the following basic steps.

1. Identify relevant primary documents to be synthesized: These documents included grantee final reports, summaries, and publications.
2. Generate key discussion topics to guide the synthesis: These topics were aimed at illuminating how the EQM grants addressed the programmatic objectives of the FOA, and how their results answered the questions posed in the FOA.
3. Code selected descriptive data for each grant: These codes describe key aspects of each grant project that are useful for addressing the discussion topics.
4. Assemble notes and observations about each grant: Several synthesis team members reviewed each grant and prepared notes summarizing aspects of each grant relevant to the discussion topics.
5. Generate and refine illustrative examples from the grants: Based on the coded data, notes and observations, the synthesis team engaged in a series of discussions to identify the most illustrative approaches, findings, and lessons from the grant materials tied to the objectives of the EQM initiative.

The body of the report is organized around five of the main objective areas from the FOA:

- Developing New Measures - Using EHRs to develop new quality and safety measures, addressed in **five grants**.
- Accuracy of Measurement - Testing the accuracy of data from EHRs for quality and safety measurement, addressed in **10 grants**.
- Capturing and Integrating Data - Determining approaches for data capture, extraction, and integration, addressed in **12 grants**.
- Feedback to Clinicians - Supporting practice-based demonstrations of feedback to clinicians to improve quality, addressed in **six grants**.
- Efficiency of Measurement - Assessing the efficiency of quality and safety measurement, addressed in **three grants**.

## Developing New Measures

### Background

Traditional approaches to clinical quality measurement involve labor-intensive, time-consuming manual chart reviews, analysis of claims data from third-party payers, voluntary reporting of rare or adverse events, or combinations of these approaches. Some quality measures are difficult to implement using these approaches as the costs of manual review may be prohibitively expensive, the analysis of claims data may lack clinical nuance and accuracy, and voluntary reporting systems can be underused. The use of EHRs and other types of health IT make it possible to estimate new quality or safety measures in terms of the clinical focus or process of care. We consider an EQM grantee to be engaged in new measure development if they are refining or testing a measure that is not part of an established measure set or endorsed by a national measurement organization or agency.

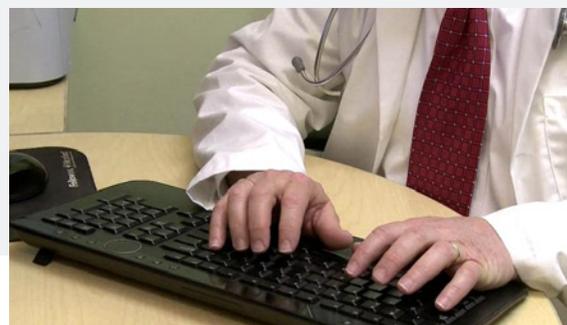
### Highlights From the Grants

Five of the grantees' pursued innovative approaches to create and test the feasibility, accuracy, and/or validity of new health IT-enabled measures that would be difficult if not impossible to implement efficiently through chart review and/or analysis of claims data. By using EHR-based data, grantees expanded the scope of measurement along multiple dimensions, including clinical services and care processes. An important step for any new quality measure, whether it is an outcome or process measure, is the validation of that measure. Because many of the new measures related to processes of care, grantees sometimes tested the association between higher scores on the measures and positive patient outcomes (i.e., measure validity). It is not surprising in this short grant period, and given the difficulty in mapping clinical outcomes, that many grantees who chose to generate new quality measures focused on process or intermediate outcome measures. Highlights of grantees who sought to generate new quality measures include the following:

- **Turchin** developed and tested the validity of a novel process measure that identifies instances of treatment intensification for diabetes medication therapy through use of natural language processing (NLP) to search provider notes in the EHR. The measure was associated with improved control of hemoglobin A1c and lipids.
- **Kaushal** engaged an expert panel to review an extensive set of existing measures related to the quality of ambulatory care; of those, the panel identified 18 prioritized existing measures to be generated by EHRs. Fifteen of these measures were subsequently included in the stage 1 Meaningful Use objectives arising from the HITECH Act. As part of this process, the panel also identified five topics not well represented in existing measures, including test ordering, medication management, referrals, followup after discharge, and revisits. The panel created definitions for 14 new measures to address these five topics.



This video highlights Dr. Rainu Kaushal et al.'s innovative approach (Grant No R18 HS 017067) to developing prioritized electronic quality measures, poised to benefit by health information exchange. Please view this video: [MOV \(60MB\)](#). For more information, see the two-page overview and final report for Dr. Kaushal's project ([PDF](#)).



- **Thomas** developed and refined two electronic “triggers” (signals that prompt record review) that might be associated with a diagnostic error—an unplanned hospitalization within 14 days of a primary care visit, and one or more unscheduled primary care, urgent care, or emergency room visits within 14 days of a primary care visit.
- **Vogt and Williams** developed EHR-based indices for the quality of cardiovascular-related disease management services in primary care, a class of services not addressed by existing measures. The measures, which take into account the pattern and level of guideline adherence over time, would be difficult if not impossible to calculate using chart review or other methods. The grantees confirmed that higher scores on the disease management indices for blood pressure were associated with lower myocardial infarction and stroke incidence, and lower utilization of outpatient and emergency department visits.
- **Berner** tested a method for gathering patient feedback following ambulatory visits via telephone and interactive voice response (IVR), which allows a patient to talk to a computer over the telephone. In one site, IVR calls were triggered by information in the EHR, and the information gathered from patients was transmitted back to the clinician entirely automatically. The patient feedback was used to calculate new measures of patient-reported problem resolution, medication adherence, and followup activity.

## Accuracy of Measurement

### Background

Quality measures should be accurate, capturing a high proportion of cases that meet the criteria for the measure without generating many false positive results. In the quality measurement arena, the accuracy of a measurement approach is often tested on a sample of patients through a comparison to manual chart review. While often viewed as a “gold standard” for accuracy, the time and cost involved in manual chart reviews can be prohibitive for routine use in quality assessment. In other situations, such as surveillance of rare, hard-to-identify events that may have catastrophic consequences, such as adverse drug events (ADEs), timely chart review is not feasible.

### Highlights From the Grants

Ten grantees studied the accuracy of health IT-enabled measurement of performance. Taken as a whole, these activities generally found that the accuracy of health IT-enabled calculations is relatively high compared to manual chart review and requires significantly less time and effort. The use of EHR data for calculating quality measures may also allow for a greater number of providers and/or patients to be included in measurement, which may help in meeting other measurement objectives. Highlights from the grantees include the following:

- **Lehmann** implemented flags in the EHR to identify those in need of medication monitoring according to measures developed by the National Committee for Quality Assurance. This approach proved to be significantly more accurate than manual chart review (higher positive predictive value (PPV), sensitivity, and specificity) based on an expert review of both sets of results.
- **Mostashari and Wu** assessed the accuracy of a set of EHR-based quality measures that address high-priority public health issues. While some measures exhibited high levels of agreement between calculations based on EHR data and manual chart review, others did not. System integration and provider workflow issues limited the ability to capture structured data and hindered the comparison. More information on this project can be found in AHRQ’s *Research Activities*: <http://www.ahrq.gov/research/jul12/>
- **Kaushal** tested the reliability of electronic generation of 11 established measures that were in use at a local FQHC, finding an overall sensitivity of 88 percent and specificity of 89 percent compared to manual chart review. Reliability varied considerably across measures, with those relying on data from both structured fields and unstructured notes (e.g., measures related to medications and tests generally done by specialists) tending to be less reliable.
- **Hazlehurst** tested an NLP approach to the measurement of 18 measures related to the quality of outpatient asthma care. Most health IT-enabled measures gave results comparable to manual chart review in the Kaiser Permanente Northwest system, with overall PPV of 88 percent and sensitivity rates above 60 percent for 16 of the 18 measures.
- **McColm** found through comparison of manual coder performance with electronic extraction and coding of data from the EHR, that the latter approach was highly accurate for case identification for blood pressure, hemoglobin A1c, and low-density lipoprotein (LDL) data elements.

- **Kilbridge and Bailey** used NLP to search clinical, demographic, encounter, laboratory, and pharmacy data to identify ADEs in children with cystic fibrosis, sickle cell disease, and cancer, populations that have not been studied in this way previously. The system did not perform as well as chart review with respect to sensitivity (43 versus 86 percent) or PPV (16 versus 59 percent) based on an expert consensus gold standard, but it identified 4 to 20 times more ADEs than the typical voluntary reporting system.
- **Turchin** tested the accuracy of a new process measure that identifies instances of treatment intensification for diabetes medication therapy through use of NLP to search provider notes in the EHR. The study found the measure to be highly accurate at identifying medication therapy intensification compared to manual review of provider notes.
- **Thomas** compared the accuracy of triggers for identifying diagnosis errors using a sample of nearly 2,000 medical records that they system had flagged for possible errors. The electronic triggers had a higher PPV than any other know method of large scale diagnostic error detection.

## Risk Adjustment

Two grantees sought to improve the accuracy of comparisons of provider performance among groups of providers. Such approaches, if successful, could provide a better assessment of the quality of care, while not unfairly penalizing providers dealing with more challenging patient populations. Examples include the following:

**Weiner** developed a measure to address the concern that some diabetes patients are inherently more difficult to bring to recommended levels of hemoglobin A1c, blood pressure, and low-density lipoprotein, even when the clinician uses all recommended therapies. The goal was to avoid penalizing clinicians caring for these difficult-to-control patients in comparative clinician studies. The measure uses a case-mix adjustment model to account for patient heterogeneity, comparing actual hemoglobin A1c, blood pressure, and low-density lipoprotein levels to expected levels. The methodology needs ongoing refinement, as the clinician rankings varied significantly depending on the assumptions used, and the variations across clinicians generally lacked statistical significance, except for differences between the very highest- and lowest-ranked clinicians.

**Kmetik** tested the accuracy of patient, medical, and system-related reasons for excluding patients from measure denominators. Overall, the frequency of exclusions was relatively low, and the health IT systems identified them accurately compared to manual chart review. Accurate identification of exceptions can better align quality measurement with the need to take into account clinical judgment, thereby making measures more comparable across providers.

## Capturing and Integrating Data

### Background

EHR systems are primarily designed to support and document the state of health of a patient, including their ailments, medications, and history of receipt of health care services. The data stored in EHRs can also be used for quality measurement if it is adequately captured at the point of care, extracted from the clinical databases where it is stored, and integrated with data from multiple sources and systems when necessary.

### Innovative Strategies for Data Capture and Extraction

Grantees used at least one of two major strategies to enhance the ability of health IT systems to capture and extract the data needed for accurate and reliable quality measurement, structured data, and NLP.

### Strategies To Capture Structured Data

Several grantees developed and implemented customized prompts, templates, and other tools to allow providers to enter relevant data in a standardized format, in some cases working directly with EHR vendors. Examples include the following:

- **McColm** tested a new approach to template documentation. Rather than using individual diagnosis or problem-focused templates, the project team created a comprehensive template and new associated functionalities (e.g., queries to document eligibility requirements and exceptions) to allow providers to document care for the top 30 presenting problems. The resulting template covered 62 measures, and the system proved effective in capturing the necessary data elements for each of them.
- **Davidson** worked with nine local community health centers that collaboratively defined user requirements for a shared quality information system to inform the technical specifications for the system, including templates for capturing data related to diabetes and smoking cessation. The work resulted in development of a request for proposal to vendors for EHR enhancements.

- **Mostashari and Wu** created health IT tools to assist primary care physicians in small practices in measuring the quality of care. The system allowed for customization of the user interface via templates and structured fields that capture clinical information, thus minimizing use of free text. The software “hard-coded” 34 existing measures into the EHR, making them easily accessible to the provider.
- **Logan** implemented and evaluated a set of 15 measures of the quality of colonoscopy procedures, based on the recommendations of several national professional society task forces. The study confirmed the feasibility of the generating the measures using data captured at the point of care through custom data entry screens in a specialty-care electronic medical record.



This video highlights Dr. Judith Logan et al.’s (Grant No. R18 HS 017067) innovative approach to using electronic health records (EHR) to generate quality reports for colonoscopies. Please view this video: [MOV \(60MB\)](#). For more information, see the two-page overview and final report for Dr. Logan’s project ([PDF](#)).



Data capture for quality measurement was hampered when it did not fit into existing systems and work flows (including the natural patterns and timing of data flows). The experiences of several grantees highlight this issue:

- **Mostashari and Wu** found that providers across 56 separate sites were less likely to complete structured data fields (e.g., capturing smoking status and counseling activities) if the data entry process did not fit into existing clinical work flows. Some sites exhibited “upgrade fatigue” when the researchers had to initiate several fixes to the software, some of which interfered with their work. Researchers are working on a fix that will be less disruptive to the sites.
- **Davidson** found that physicians at one site were initially not consistently documenting the “advise” component of tobacco cessation counseling, because the documentation for that component occurred in a part of the electronic chart they did not normally use (rather, medical assistants used it). Researchers subsequently moved this component to the provider section of the electronic clinical note (i.e., the progress note), which helped to increase the documentation rate.
- **Logan** found that only one of 35 sites entered information on pathology results into a system capturing various aspects of colonoscopy procedures. Because this information came in after the procedure, entering it manually did not fit naturally into existing workflows. However, when data entry could be integrated into point of care documentation workflows, it tended to be more successful.
- **In Hazlehurst**, Kaiser Permanente Northwest and a consortium of FQHC clinics used an existing medical record classification technology to create and validate a clinical data processing “pipeline” that combined free-text and coded elements of clinical visits to assess adherence to outpatient asthma guidelines. NLP extracted information from provider notes to supplement the structured data. Half of the 22 asthma measures required the processing of providers’ text notations to identify events that quality for the numerator, while five other measures were demonstrably improved by use of NLP (as compared to using only structured data).
- **In Turchin**, researchers developed NLP software to extract information on insulin dosing, which generally appears in the narrative rather than structured prescription data, to identify patients for whom medication therapy was intensified.
- **Kilbridge and Bailey** combined use of a rules-based expert system to extract discrete data with the use of NLP to scan free-text in outpatient clinic notes, discharge summaries, inpatient consult notes, nursing documentation, and other narrative sources for words and phrases suggestive of ADEs.

### Strategies To Extract Unstructured Data

Three of the grantees made use of NLP techniques using advanced algorithms to search the free-text portions of the EHR (e.g., narrative notes) to extract relevant data for quality measurement. Grantees used internally developed NLP systems to supplement to data captured via existing, structured fields and templates in the EHRs. NLP can leverage unique information such as clinician notes which are not available in the structured fields. Examples of grantees using NLP include:

On April 11, 2012, AHRQ hosted a Webinar featuring Drs. Turchin and Hazlehurst on the use of NLP to improve quality measurement. Information about this Webinar can be found at:

<http://healthit.ahrq.gov/nlp-eqmwebinar>

Two grantees (Mostashari and Wu and Logan) did not make use of NLP in their EQM grants, but noted after the fact that the technology could have been a useful addition to their data capture strategies, allowing for the extraction of important information not available in structured fields. Another grantee not using NLP (Kaushal) noted that the reliability of certain measures where performance is calculated based only on structured data, could potentially be improved by NLP once the technology becomes more “sophisticated and routine.”

### Innovative Strategies for Integrating Data From Multiple Sites and Sources

Health IT can improve quality measurement by bringing together data from multiple sites and data sources more efficiently than manual review of records from each site or source. However, all the data must be consistent and comparable. The process of bringing the information together—commonly referred to as “data integration”—can be challenging. The various systems may not communicate with each other, and the data may not be coded and/or stored in the same place or manner or available at the same time. Grantees devoted a significant amount of time to mapping information from multiple sites and sources, taking into account variations in coding practices, database designs, and data availability. (Mapping refers to the process of determining which data elements from different systems or sources get used in the calculation of quality measures.)

Grantees from integrated health systems and/or from groups with a history of collaboration on data sharing (e.g., practice-based research networks) seemed to have a “head start” in this area, as the multiple sites involved used similar systems and/or had access to an integrated database. For example, Thomas leveraged an existing electronic data repository that contained administrative and clinical data extracted monthly from the EHR. The two participating sites used this system to identify and learn from ambulatory diagnostic errors. In most cases, however, creative, new strategies were required of these grantees in order to pursue data integration,

even in organizations with significant experience using EHRs (including those using the same system across sites). Examples of grantee activities in this area are highlighted below:

- **Vogt and Williams** developed EHR-based quality indices for 11 cardiovascular primary care services, relying as much as possible on pre-existing EHR data elements meeting preliminary quality assurance and standardization requirements by virtue of inclusion in the health maintenance organization (HMO) Research Network’s Virtual Data Warehouse. Even though the indices were implemented in Kaiser Permanente sites that had substantial experience using the same EHR, grantees had to create an extensive process for extracting, cleaning, and coding the data.
- **Lazarus** created an a vaccine adverse event reporting system that prospectively integrates diagnostic codes, laboratory tests, allergy lists, vital signs, and medication prescriptions for patients who receive a vaccine. The system built on an existing EHR and daily extractor system. The grantee team augmented that system by creating a datamart that uses a reporting protocol and corresponding algorithms to identify prescriptions or abnormal laboratory values that might suggest an adverse event. A physician reviews potential adverse events to confirm their existence, which can then be reported via a Health-Level 7 message to the Centers for Disease Control and Prevention (CDC) National Vaccine Adverse Event Reporting System.
- **Lehmann** developed a bidirectional interface between the EHR at two FQHCs and a laboratory, thus allowing for health IT-based medication monitoring for vulnerable populations.

- **Schneider** attempted to develop a measurement approach that integrated data from primary care practices participating in three community-wide, multipayer HIE efforts. A range of barriers prevented a successful evaluation of the adequacy of these data sources for performance measurement, including the legal status of data sharing between HIEs and evaluators, conflicting Institutional Review Board recommendations related to Health Insurance Portability and Accountability Act (HIPAA) regulation, timeliness of health plan legal review and data sharing, difficulty engaging patients in consent for evaluation of data, and challenges engaging ambulatory clinical practices in a difficult primary care environment.
- **Weiner** integrated EHR data from two institutions that cared for some of the same patients, a private system and a Veteran's Administration system, to test a method of risk adjusting physician-level diabetes quality of care rankings. Using a linkage between database tables of demographics and patient identifiers from the two systems, the researchers were able to find patients with visit activity in both locations and conduct a descriptive analysis of their patterns of care.

## Feedback to Clinicians

### Background

The EQM FOA recognizes that the ultimate purpose of quality measurement is to stimulate quality improvement over time by allowing providers to understand their performance and to identify specific opportunities to enhance the provision of care by more consistently providing guideline-recommended care processes.

### Highlights From the Grants

The EQM FOA focused on innovations in quality measurement and feedback. Six of the grantees provided measurement feedback to clinicians or clinical teams with the aim of improving the quality of care delivered. Five grantees documented improvements in quality (Berner, Davidson, Kaushal, Lehmann, and Mostashari and Wu), including one that did not provide feedback reports (Kaushal). While generalizations are difficult because of the small number of grants and the wide variety of strategies used, success seemed to be driven by the degree to which providers received useful, timely, and actionable performance feedback and decision support, as illustrated by the examples below:

- **Berner** used different methods to proactively contact patients following an office visit to gather information that was then fed back to physicians. The information sent to the physicians included whether the patient's problems had been resolved, whether the patient adhered to prescribed medications, and the patient's satisfaction with the care received. Physicians could view these feedback reports whenever they opened the EHR. While the study did not evaluate their impact on patient outcomes, 78 percent of physicians looked at the reports, with most reviewing them once a week. Most physicians reported conducting further followup on those patients whose reports they reviewed, and just under two thirds wanted to continue receiving the reports.
- **Davidson** found that use of built-in templates to support clinicians providing and documenting care led to meaningful improvements in measures related to smoking cessation at some sites.
- **Selby** offered feedback to staff responsible for population management on the need to intensify medication treatment for those patients with out-of-range values. The feedback had a modest impact on treatment intensification rates for patients with elevated systolic blood pressure and low-density lipoprotein levels. However, the feedback had no observed impact on the associated outcomes measure—i.e., the proportions of patients with these levels in the target range. To address this issue, population management staff suggested that the feedback be more timely and include patient-level data on medication adherence. The study team worked with operational leaders to update the flags and feedback accordingly, and hosted a series of Webinars to train population care management staff on their use.
- **Mostashari and Wu** provided patient-specific clinician reminders and decision support at the point of care (e.g., patient registries, reminders and alerts, and comprehensive order sets) and real-time reports in the EHR that displayed a provider's overall performance on the quality measures. Provider performance on nearly all measures exhibited statistically significant improvements, ranging from 5 to 20 percentage points per measure.
- **Lehmann** gave primary care providers an EHR-generated paper bulletin listing patients due for therapeutic monitoring tests related to one or more medications. Patients appearing on the bulletins were somewhat more likely to receive monitoring within 2 months than those who did not, suggesting the reports had a positive impact. However, providers reported that the bulletins were too long and did not provide specific instructions on how to manage patients. (The researchers addressed the first issue by revising the list to include only the 10 most overdue patients.)

- **Logan** posted monthly, physician-specific performance reports that included aggregate information for the past 6 months for the physician compared to the average of all participating physicians as a group. Based on feedback from participating physicians, the researchers streamlined the reports and integrated them into the EHR. Analysis of the impact of the reports is in progress.
- **Kaushal** found that the performance of primary care providers improved over time as they used EHRs that included a built-in set of validated, reliable quality measures, even without performance feedback to providers. The performance of 45 providers improved on all 10 evaluated measures with a mean improvement of 14.9 percentage points, ranging from 3.3 percentage points for asthma medications to 33.1 percentage points for colorectal cancer screening.

Clinicians often want to participate in determining which measurement and improvement-related activities are implemented and how they should be structured to fit into daily workflows. They also often need training, tools, and support to help them perform these activities. Such support can be important even in situations where providers had substantial prior experience using EHRs. Multiple EQM studies illustrated the importance of engaging providers to get their upfront input, and giving them ongoing support as outlined below:

- **In McColm**, grantees created a single, comprehensive template based on input from providers that highlighted the difficulties of juggling the existing array of templates. Provider input also convinced them to incorporate speech recognition to help providers use documentation processes efficiently and maintain some narrative

to present the “story” or “gist” of the encounter. Providers and nurses also received extensive training on new templates, tools, and queries through online learning and classroom and one-on-one sessions. In addition, they had access to tools and methods that helped them become more efficient and effective in using EHRs during patient encounters.

- **In Mostashari and Wu**, participating practices received extensive onsite training in using clinical decision support and quality reporting, along with bimonthly in-person visits from quality improvement specialists and step-by-step instructions.
- **In Davidson**, grantees conducted brainstorming sessions with interdisciplinary groups at each clinic to ensure the integrity of the data and make sure that the data entry and documentation processes would create value to those performing them. Adoption of templates worked best when providers received education on the clinical guideline content and training on use of the template at the same time (versus being trained on the guideline and template separately).

## Efficiency of Measurement

Electronic systems performed well in identifying relatively rare events, such as adverse drug events and diagnostic errors. These systems can efficiently review large numbers of records in search of these events. Effective data integration is particularly important for identifying these quality problems, since the relevant records generally exist in multiple formats, settings or sources. While the EQM grantees had minimal engagement of health information exchange across different health care entities, a few of the grantees sought to complement the use of standardized data by exploring the role of NLP. Examples of grantee activity in this area are highlighted below:

- **Kilbridge and Bailey** used NLP to search clinical, demographic, encounter, laboratory, and pharmacy data to identify pediatric ADEs. This approach required only 8 to 10 minutes of pharmacist review time per flagged case compared to nearly 2 hours for a full chart review. This efficiency enabled the researchers to identify a greater number of serious ADEs.
- **Lazarus** created a method for prospectively integrating diagnostic codes, laboratory tests, allergy lists, vital signs, and medication prescriptions for all patients who receive a vaccine, with the goal of identifying potential adverse events related to

vaccinations. Data collected over a 3-year period on 715,000 patients and 1.4 million vaccine doses found that 2.6 percent of vaccinations resulted in possible reactions. The grantees concluded that this approach had “the potential to speed the identification of problems with new drugs and to allow for more careful quantification of the risks of older drugs,” as this number of cases would not be practical to review using manual methods.

- **Thomas** applied electronic triggers that might be associated with a diagnostic error to over 212,000 primary care visits, a number too large to assess by manual chart review. This methodology was far more efficient than conducting random record reviews, and it identified errors that were more consequential than many routine errors, but also less recognizable than obvious, critical errors that might be detected by self-reports.

## Conclusion

The EQM grantees demonstrated significant progress towards addressing AHRQ's goals of advancing quality and safety measurement through the use of health IT. They developed and tested new measures, assessed the accuracy and efficiency of health IT-enabled measurement, addressed IOM priority areas for quality improvement in a variety of ambulatory care settings, and examined approaches for providing measurement feedback to clinicians and clinical teams to improve the quality of care, consistent with the EQM FOA objectives. Grantees confronted the challenges of data capture, extraction, and integration across data sources using innovative approaches to improve the completeness of structured data, and testing the use of NLP for analysis of free text. The findings and lessons from the EQM initiative can inform researchers and front-line implementers who have a stake in using health IT for quality and safety measurement and improvement. The rapid pace of technological change, plus the dynamic health care policy and reform environment, make the results of this body of research even more timely and relevant.

Two of the seven EQM objectives were not substantively addressed by the 17 EQM grantees. These were to study how to use interoperable data systems to measure quality and safety for episodes of care across settings, and using HIE as a data source for quality and safety measurement, including public reporting. These remain important yet difficult areas where additional research can inform the discussion about how to facilitate secure data sharing across health care organizations to support the delivery and improvement of care. The EQM initiative highlighted successes in the use of EHRs for care delivery and quality measurement within organizations, while illustrating the recognized major national challenge, the need for improving the interoperability and connectivity of health IT systems between organizations.