Grant Final Report

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Improving HIT Implementation in a Rural Health System

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Abstract

Purpose: This project was intended to build upon the existing ambulatory EMR project in the MaineGeneral community to improve safety, quality, access, and cost of healthcare. We would share a single EMR platform across the community, build an implementation team and process that could continue dissemination after the grant period, and develop data to show effects on healthcare quality, safety, access, cost, and practice finances.

Scope: We intended to complete the installation in 7 pilot practices and add 12 more practices in 3 grant years.

Methods: The project was a case study of an ambulatory EMR implementation in one rural setting. Data analyzed included surveys, clinical and process data from clinical and administrative databases, and insurance claims data.

Results: By the close of the grant period, we had implemented in 30 practices serving 68,000 active patients. There were 12 practices awaiting implementation. Data showed mixed results regarding quality of care and marginally worse access to care, cost of care, and financial performance. User enthusiasm and participation increased over the years to find ways to use the system to improve processes and outcomes.

Key Words: Ambulatory EMR; EHR; Health IT; Quality; Access; Decision Support; Quality Reporting

Final Report

Purpose

This project was intended to build upon the existing ambulatory EMR project in the MaineGeneral community to improve safety, quality, access, and cost of healthcare in the region.

Build on the existing ambulatory EMR environment by:

- Complete the implementation of all EMR modules in existing EMR sites
- Implement in 12 new sites including private practice sites within the 3 year grant period
- Emerge from the grant period with a plan to implement in all MaineGeneral affiliated practices.

Improve safety of the local healthcare system by disseminating electronic prescribing tools.

Improve quality of the local healthcare system by implementing clinical reminders during office visits, tickler systems between office visits, and protocols to enable the delivery of interventions by support staff.

Improve access to healthcare by using EMR as part of a system to decrease visit rate per patient per year and increase the visit rate per doctor per hour, thus increasing the patient panel size per doctor.

Use ambulatory EMR to reduce the cost of care from the patients perspective by:

- Provide decision support tools to support staff to enable more non-visit care
- Reduce unnecessary specialty visits, emergency room visits, and hospitalizations.
- Use decision support tools to decrease the cost of pharmaceuticals
- Share electronic data across practices in the community reducing cost of gathering patient data and the duplication of tests and treatments.

Scope

Background

MaineGeneral Health (MGH) is a rural Health System in Central Maine and came to the project committed to the implementation of an outpatient electronic medical record (EMR). In the year 2000, a process was launched to evaluate local provider's needs and choose a product. In 2002, the Touchworks product from the vendor Allscripts was chosen for implementation as an enterprise-wide EMR for both practices owned by MaineGeneral and independent practices affiliated with MaineGeneral. Seven primary care practices owned and operated by MaineGeneral were chosen as pilot sites and a staged implementation was begun in January 2003. Implementation of the EMR was separated into distinct phases to match the expected learning curve and to reduce the potential loss of practice productivity often associated with an EMR. At the time of award, the first phase of EMR implementation had been completed at 7 sites. The first phase included electronic prescribing, allergy list, medication list, problem list, and tasking functionalities.

Context

MaineGeneral Health serves 140,000 patients in rural central Maine. It is the third largest health care organization in the State of Maine. The network consists of two acute care hospitals, a 9 site/ 26 physician multi-specialty group practice; a nationally recognized family practice residency with 29 residents; and a 256 member physician-hospital organization. The 281 physicians on the medical staff are organized into 104 practices. 24 of the practices are owned by MaineGeneral. The remainders are either private practices or owned by other corporate entities.

Settings

Of the 104 practices affiliated with MaineGeneral 29 are primary care practices, 59 are solo practitioners, 33 are groups of 5 physicians or less. All are in communities classified as rural by the United States Department of Agriculture.

Participants

Augusta Family Practice, Family Medicine Institute, Four Seasons Family Practice, Gardiner Family Practice, Kennebec Pediatrics, Maine Dartmouth Family Practice, Winthrop Family Practice, MaineGeneral Health, MaineGeneral Medical Center, MaineGeneral Health Associates, Kennebec Region Health Alliance, Maine-Dartmouth Family Practice Residency Program, State of Maine Immunization Registry, State of Maine Bureau of Medical Services, Allscripts Healthcare Solutions, MaineMSO, Northeast Healthcare Quality Foundation, MaineMSO.

Prevalence

At the start of the project, of 104 medical practices affiliated with MaineGeneral, seven practices were participating in the MaineGeneral ambulatory EMR project. Seven other practices had previously implemented other EMR systems.

Methods

Study Design

The project was a rural EMR implementation demonstration, essentially a case study. Longitudinal process, clinical care, access and costs measures were collected throughout the three year project at the implementation sites. Where possible, comparison data from similar Maine non-participating practices were used to assess the impact of the implementation.

Data Sources/Collection

Process, clinical care, access/utilization, costs, and financial performance were measured. Data collection included:

- clinician and patient surveys from each participating practice;
- manual medical record audits of the paper and electronic chart comparing the documented quality and the location of the documentation through the project
- EMR data reports documenting clinician use of the EMR and clinical quality of care measures.
- EMR and practice financial system analyses of patient utilization
- Practice financial systems for practices expense and revenue analyses
- The MaineGeneral budgeting system to track the cost of EMR acquisition, implementation and support
- Insurance claims data from a statewide all-payer database maintained by the Maine Health Information Center to assess comparative healthcare costs from the payer perspective. Insurance claims data was the one data set that delivered credible control group comparisons.

Interventions

Implementation of an ambulatory electronic medical record at seven outpatient practices and expansion to additional practices.

Measures

Clinician and patient satisfaction surveys, as well as qualitative assessments of the implementation from perspectives of the EMR implementation team and administrative and clinical support staff were collected. Pre- and post- implementation comparisons on audited clinical care metrics in the demonstration practices were used to assess impact on quality of care, e.g., diabetes quality care metrics. Utilization of EMR features, such as electronic prescriptions, problems lists, tasks, and billing documentation were measured over time. Finally, insurance claims data were used to assess impact on access, utilization and costs during the project.

Limitations

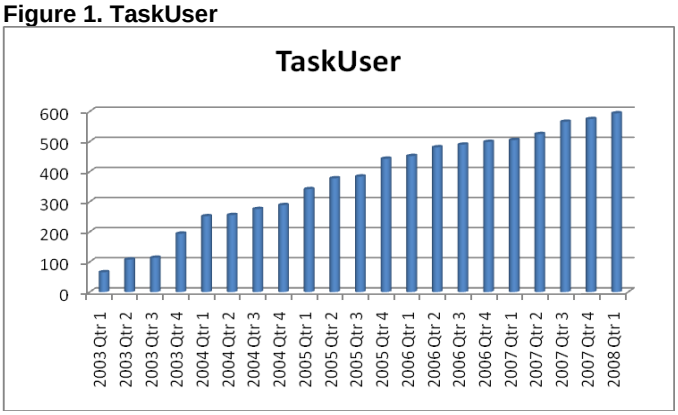
This implementation project took place in only one set of outpatient practices in rural Maine. Since the initial hospital-sponsored practices had already committed to implementing an ambulatory EMR. A multitude of project factors, practice factors, network factors, and environmental factors render this project unique and limit the applicability to other projects.

Results

Domain 1: Process Documentation

1a/b: Quarterly Number of Users. The chart "TaskUser" is the count of unique users who created any kind of task in each quarter. We show 594 distinct users in the most recent quarter.

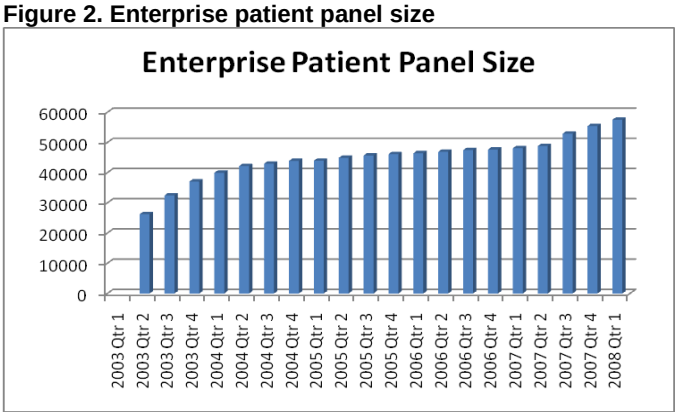
Figure 1. TaskUser



Participating Practices. Participating practices grew from 7 at the start of the project to 30 at the close.

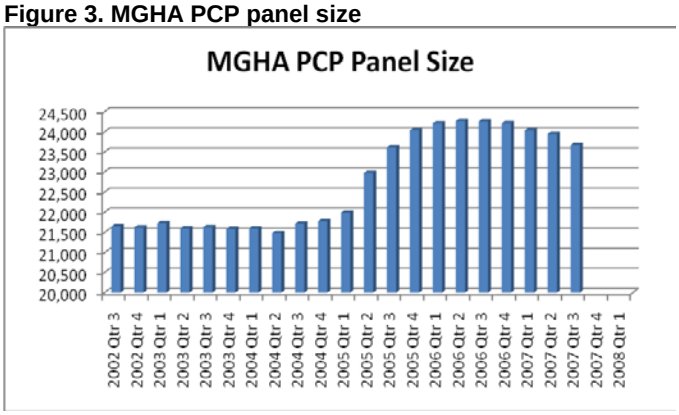
Active Patients. We performed a quarterly measure of panel size based on face to face visits of unique patients to participating practices within the previous 18 month window. The data represented in "Enterprise Patient Panel Size" represents the growth in the number of patients impacted by the EMR.

Figure 2. Enterprise patient panel size



The chart, "MGHA PCP Panel Size, tracks panel size specifically in the primary care practices which participated through the entire period. This, effectively measures the panel size of each practice, but does not adjust for possible changes in the number of providers in each practice.

Figure 3. MGHA PCP panel size

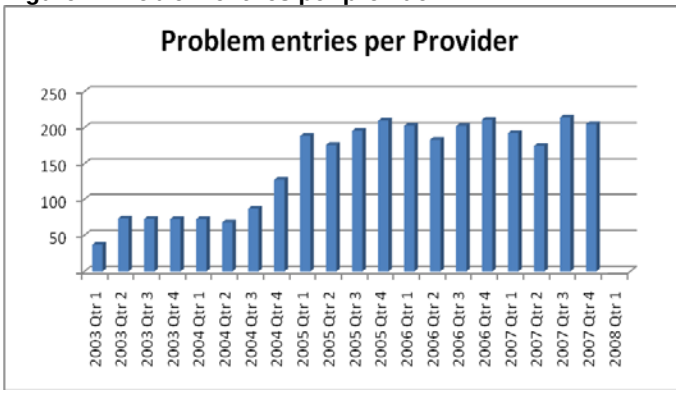


1c: Number of Problem Entries. Use of the problem list is essential to be able to use the EMR as a disease registry and is foundational to construct effective clinical reminders that will improve quality of care.

The chart "Problem Entries per Provider divides the total number of problem entries in any quarter by the number of users who have at least one problem entry in that quarter. This shows

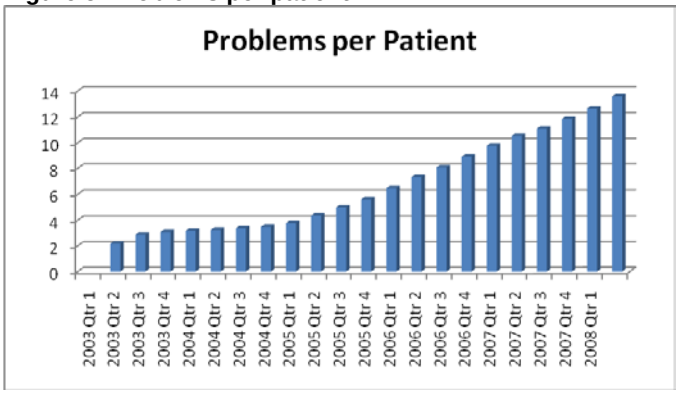
an increase in “problem” utilization after rollout of the structured note in Q1 2005. It also shows a transient annual drop in problem utilization in Q2 annually.

Figure 4. Problem entries per provider



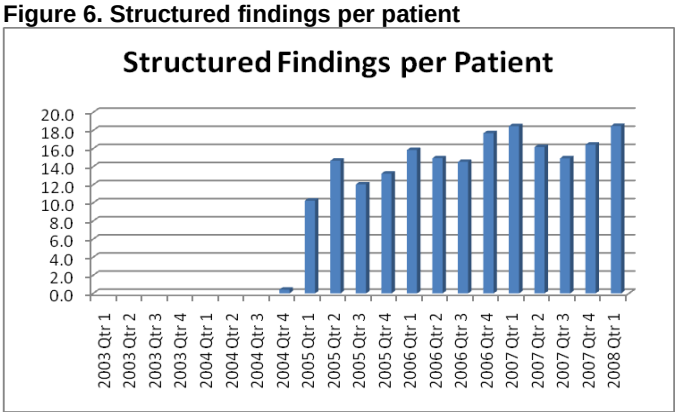
1d: Average Size of Problem List. The chart, “Problems per Patient”, measures the average size of the problem list for each patient in each quarter. We totaled the patients who were seen in each quarter, and all the problem entries associated with each patient if the problem was created during or before the encounter. Counts include problems on the lists: Active Problems, Past Medical History, Past Surgical History, Personal History, and Family History.

Figure 5. Problems per patient



1e: Average Number of Template Findings per Patient. The chart, “Structured Findings per Patient” shows the usage of structured template entries in the documentation of care for each unique patient who received care during each quarter. Use of structured finding represents advanced use of an EMR, a very different approach to the patient record than the narrative summary. Unlike narrative documentation, structured findings are accessible to advanced reporting tools.

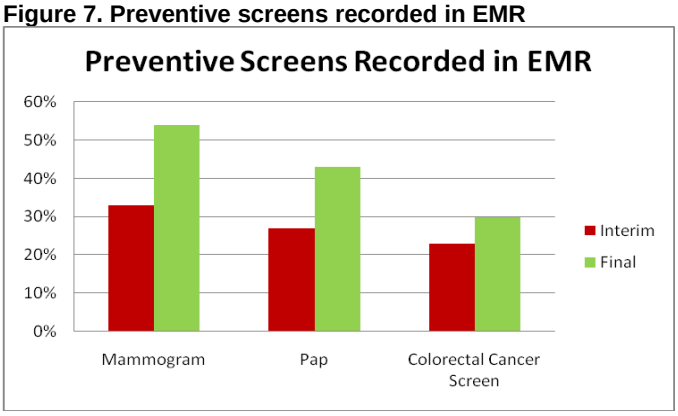
Figure 6. Structured findings per patient



Data Migration to the EMR. During both Interim and Final Clinical Reviews, a two step process of locating data for the three cancer screening measures occurred: Step 1, EMR search; Step 2, paper record search. There was an improvement in EMR documentation for all three indicators from the Interim to Final Review (mammogram: 21%; pap 16%; colorectal cancer screen: 7%). However, a significant percentage of data for all three measures continues to be located outside of the EMR.

Different data types, however, give different results. For instance vital signs, allergy lists, and medication lists are found 100% of the time in the EMR at the final measurement.

Figure 7. Preventive screens recorded in EMR



Satisfaction Survey Results

We conducted a basic 5-point users' satisfaction survey. Users have constant access to the survey on the login page. Five statements are presented to the participant:

- I rarely experience errors in the EMR.
- I rarely lose any of my work in the EMR.

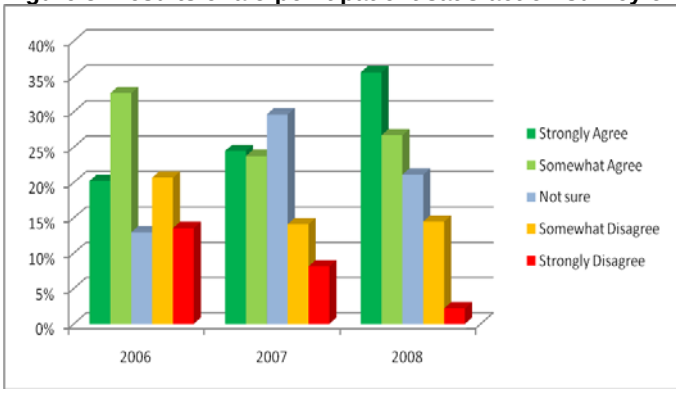
- Overall, the speed and reliability of the EMR meets my needs.
- The EMR is about as fast as other MaineGeneral systems.
- The EMR support team and website is there when I need it.

Participants respond on a 5-point scale:

- Strongly Agree
- Somewhat Agree
- Not Sure
- Somewhat Disagree
- Strongly Disagree

All questions showed a similar pattern of improvement over 3 years. To illustrate the trend, we aggregated all responses to all questions by year and normalized on percentage of responses in each category.

Figure 8. Results of a 5-point patient satisfaction survey on the EMR



Patient Surveys Regarding Electronic Record System. Rather than burden the already strained clinical support staff with paper surveys, we used existing quality/satisfaction measures employed by the practices. For brevity's sake, the overall results can be summarized by noting that there appeared to be no overall change in patient satisfaction over the implementation period.

Qualitative methods were also used to assess rapid rollout procedures satisfaction metrics. These included informal debriefings of staff and PCPs throughout the implementation. Briefly, the field notes indicate that a large majority of support staff quickly recognized the value of the system for messaging, prescription and task management. Clinicians' attitudes were more varied, but paralleling the graph above, they gradually were more satisfied with the EMR. An important

implementation change that greatly improved clinician satisfaction was the addition of EMR training staff regularly on-site at each practice.

Domain 2: Clinical Care Outcomes

Record Review for the Project Evaluation was divided into three distinct phases:

- Phase 1: Pre EMR implementation.
- Phase 2: Early EMR
- Phase 3: Mature EMR

Phase 1 Record Review. Care administered to patients prior to the implementation of an electronic record was assessed. A sample (N=50) of paper charts of diabetic patients (18 years old and older) was randomly selected at each practice for review. This review, referred to as the Baseline Summary, included a 15-month study period preceding EMR "go live" at each practice. The operative question was: Did diabetic patients receive appropriate care during the study period?

Phase 2 Record Review. Care administered to patients shortly after the EMR "go live" was assessed in this review. This Interim Summary, spanning a 15-month study period, focused first on the EMR for data abstraction. If the measure was not found documented in the EMR, the paper chart was reviewed. The focus continued to be diabetic patients (Sample size N=50; 18 years old and older). The operative questions were now: Did diabetic patients receive appropriate care? Was the data related to the specific measures located in the EMR or still in the paper world?

Phase 3 Record Review. This final review spanning a 12-month study period (8/1/2006-8/1/2007) focused, once again, on care administered to diabetic patients (Sample size N=50 at each practice site; 18 years and older). EMR use by clinical staff was now viewed as more "mature".

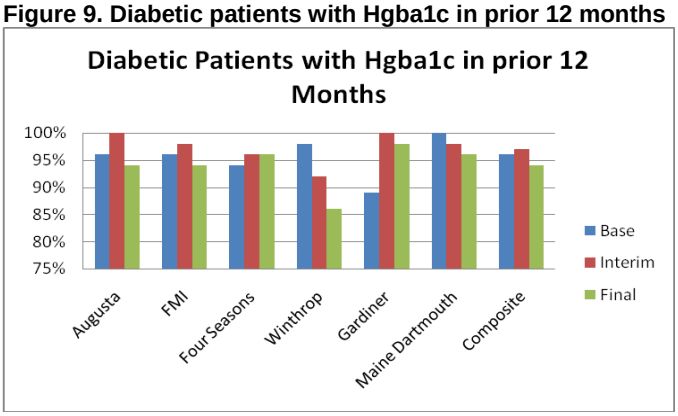
The study questions were: Did diabetic patients receive appropriate care based upon evidence located solely in the EMR? Data abstractors searched for evidence of all diabetes measures, with three exceptions, only in the EMR. Preventive measures (breast cancer screen; colon cancer screening; cervical cancer screening) were reviewed via a two-step process. If the preventive measure was not found documented in the EMR, the paper chart was reviewed for evidence. For these three measures the question was: Did diabetic patient receive appropriate care? How successfully have preventive measures data continued to migrate from the paper chart to the EMR?

Measures/ Findings

HgbA1c Performed During the Study Period. During the Interim Phase, most laboratory data was reliably found in the EMR. For example, 97% of A1c data was located in the EMR vs. the paper record during Interim Phase Review. As a result, laboratory data during the Final Phase Review was sought in the EMR exclusively.

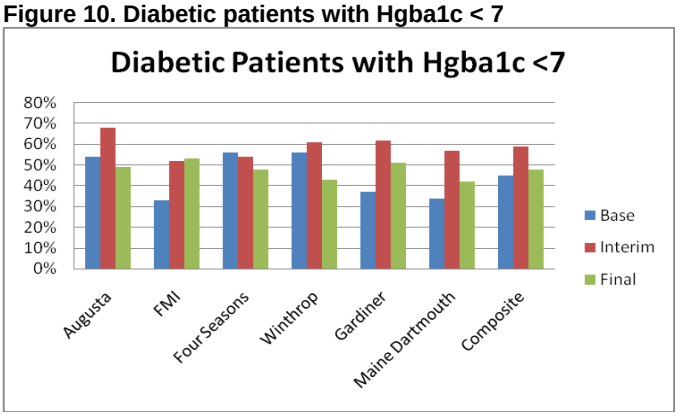
In the aggregate, there was an insignificant change from Baseline (96%) to Final Phase (94%) performance of the A1c. Gardiner demonstrated the greatest (9%) improvement in performance while Winthrop showed the largest decline in performance from Baseline (98%) to Final Phase (86%).

Figure 9. Diabetic patients with Hgba1c in prior 12 months



HgbA1c less than 7. Overall, there was a modest (3%) improvement in the percentage of patients showing good control (A1c < 7) from the Baseline to Final Phase. A number of practices (Augusta, Winthrop, Gardiner, and Maine Dartmouth) appeared to lose gains they had made from Baseline to Interim Phase. Nonetheless, there was improvement from the Baseline to Final Phase for FMI (20%), Gardiner (14%), and Maine Dartmouth (8%) and declines for Augusta (5%), Four Seasons (8%), and Winthrop (13%).

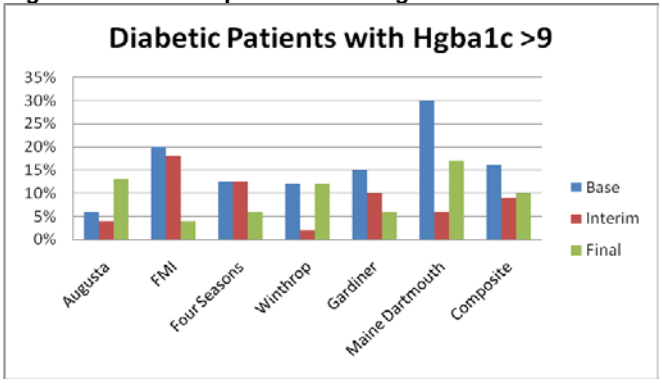
Figure 10. Diabetic patients with Hgba1c < 7



HgbA1c > 9. A recent study (Pogach, L, Michael, M, Aron, D. Measuring Progress Toward Achieving Hemoglobin A1c Goals in Diabetes Care. JAMA. 2007; (297)5:520-2.) notes that it is important to distinguish between practice guidelines and performance measures. Where there is disagreement among coalitions and organizations about the measurement most reflective of quality care that cuts across providers, populations, and plans, all are in agreement that a HgbA1c > 9 indicates poor control. In addition, absolute risk reduction is greater from 9-8% than from 8-7%.

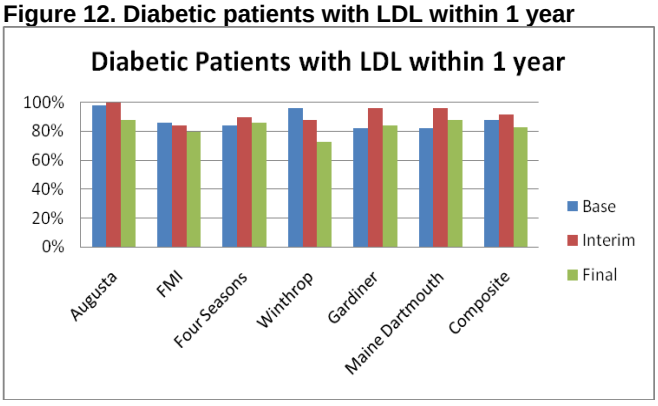
The percentage of HgbA1c values >9 declined overall by 6% from Baseline to Final Phase Review. A single practice, Winthrop, demonstrated no change from Baseline to Final Phase while Augusta showed a 7% increase in patients with A1c > 9.

Figure 11. Diabetic patients with Hgba1c>9



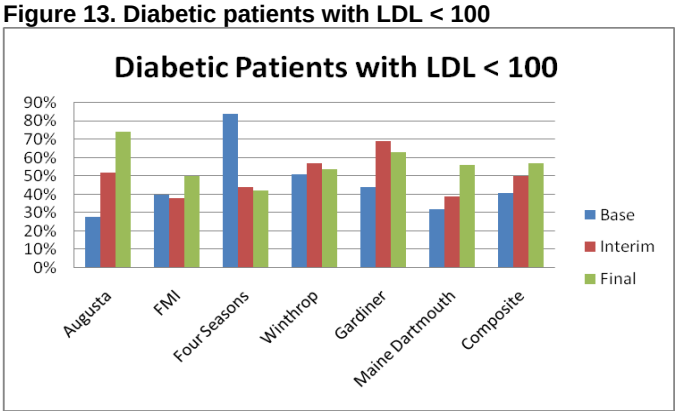
Lipid Study Performed During the Study Period. Ninety-eight percent of all Lipid studies were found in the EMR (vs. paper record) during the Interim Phase Review. Overall, these tests appear to be slightly less reliably performed than the A1c. Composite data suggests a slight improvement in test performance during the Interim phase (4%) with a final 5% decline in performance from Baseline to Final Phase Review. This would suggest that a reliable system for test performance does not yet exist. Three practices (Four Seasons, Gardiner, and Maine Dartmouth) demonstrated modest improvement from Baseline to Final review in the % of patients with lipid studies performed during the study period. Three practices (Augusta, FMI, and Winthrop) showed a decline in the % of patients tested from the Baseline to Final Review.

Figure 12. Diabetic patients with LDL within 1 year



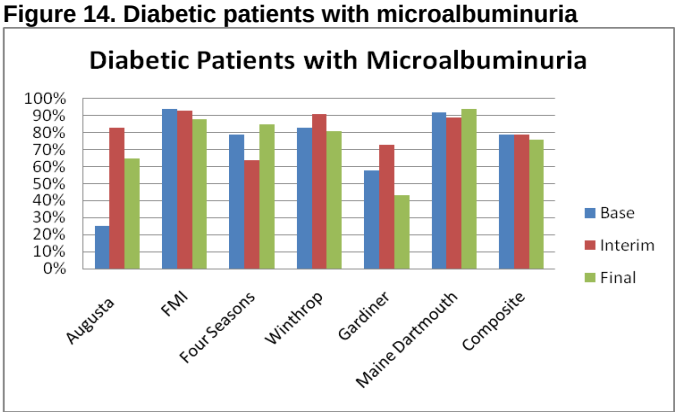
The percentage of patients with an LDL < 100 increased on average by 9% from Baseline to Interim review and improved an additional 7% from Interim to Final review. However, there were increases from Baseline to Final Review in both % of patients with HDL < 35 (17% to 24%) and elevated Triglycerides > 400 (5% to 7.2%).

Figure 13. Diabetic patients with LDL < 100



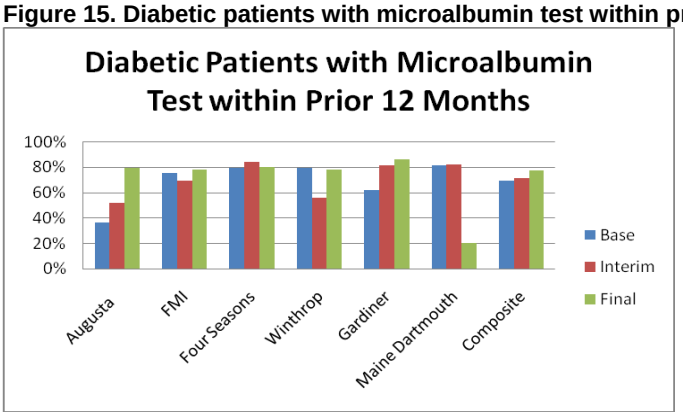
Microalbumin Test Performed During the Study Period. Overall, there was steady improvement from Baseline (69%) to Interim (71%) to Final Review (77%) regarding the reliable performance of the microalbumin test. Progress at individual sites, however, was inconsistent with two sites (FMI and Winthrop) showing declining performance from Baseline to Interim with improvement from Interim to Final Review. Maine Dartmouth alone showed a decline in performance from Baseline (81%) to Final Review (20%). In general, there is opportunity for improvement in the reliability of microalbumin screening processes. Specific processes for assuring test performance at Augusta and Gardiner may be applicable to other sites.

Figure 14. Diabetic patients with microalbuminuria



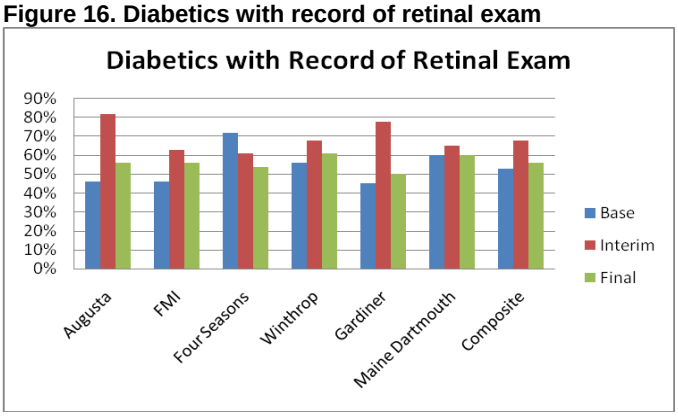
In the composite, the percentage of patients with a positive microalbumin or macroalbumin on an ACE inhibitor (or ARBs) remained unchanged from Baseline to Interim and Final measurement.

Figure 15. Diabetic patients with microalbumin test within prior 12 months



Dilated Eye Exam or Referral/Diabetics with Retinopathy. In the aggregate, there was no significant improvement in the percent of patients with an eye exam or referral from Baseline to Final Phase Review (53% to 56%). In addition, the apparent improvement in eye exam during the Interim Phase Review (68%) with subsequent loss of the gain during the Final Review may be due in part to the search in the paper record during the Interim Review but not Final Review. A full 17% of eye exam records were not located in the EMR during the Interim Review. If significant progress was not made toward entering eye exam data into the EMR, the Final Review finding may be artificially low due to continued missing data in the EMR.

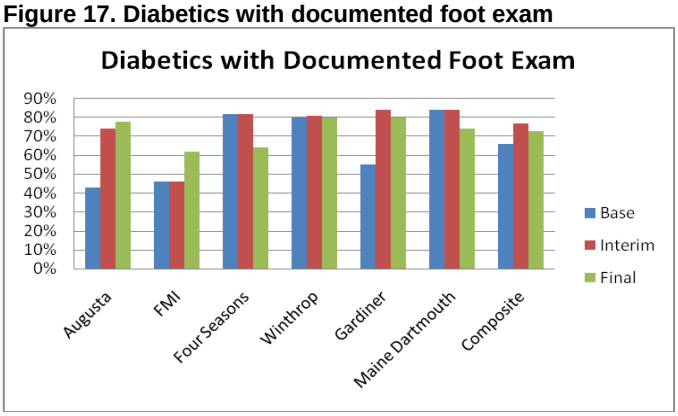
Figure 16. Diabetics with record of retinal exam



Diabetics with Eye Exam or Referral with Ophthalmology Report in the Record. There was essentially no change in this measure from Baseline to Interim review (50%). There appears to be no reliable system for obtaining ophthalmology reports. In addition, in the absence of scanning, ophthalmology reports continue to reside in the paper record.

Neurosensory Foot Exam. Overall, there was a 7% improvement in this measure from Baseline (66%) to Final Review (73%). However, there was a more dramatic gain from Baseline (66%) to Interim Review (77%). Nationally, 69% of patients surveyed via the BRFSS (2005) reported an annual foot exam by their health care provider. Once again, the Final Review focused exclusively on EMR data. Given that 9% of foot exam data was missing from the EMR during the Interim Review, if there was no significant improvement in EMR documentation of this measure between the Interim and Final Review, the Final Review data may reflect underreporting of this measure rather than non-performance of the foot exam. Given the degree of steady improvement at one site (Augusta [35%]), it may be worth exploring what processes are now in place at this site. Is the issue reliable performance of the exam, reliable documentation, or both?

Figure 17. Diabetics with documented foot exam



Influenza Vaccine and Pneumococcal Vaccine. Both of these measures showed declines in performance from Baseline to Final Review with insignificant change at the Interim Review. Influenza vaccine performance declined by 13%. Pneumococcal vaccine declined more substantially by 25%. Data capture in the EMR may continue to be the problem. During the interim review, 16% of influenza and 71% of pneumococcal vaccine records were located in the paper record but not in the EMR. National data (BRFSS, 2005) for diabetic patients stands at approximately 50% self-report for annual influenza vaccine and history of pneumococcal vaccine. The duplicative documentation process requiring submission of data to a statewide database (IMPACT) may be part of the problem. Ongoing discussion at the system level may lead to a system wide plan for administration and documentation of vaccines. One opportunity for improvement is the planned EMR interface with the IMPACT database.

Figure 18. Diabetics with pneumococcal vaccine

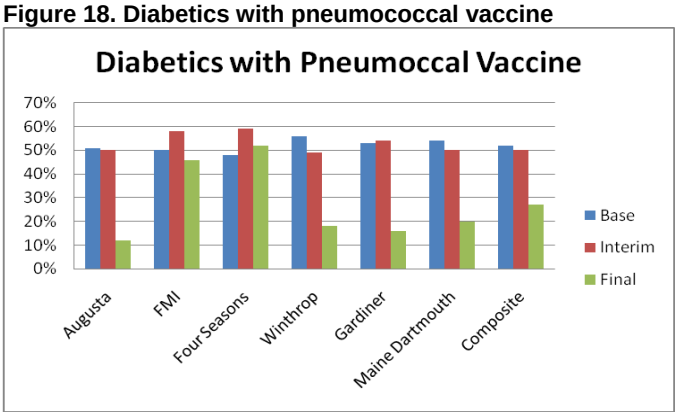
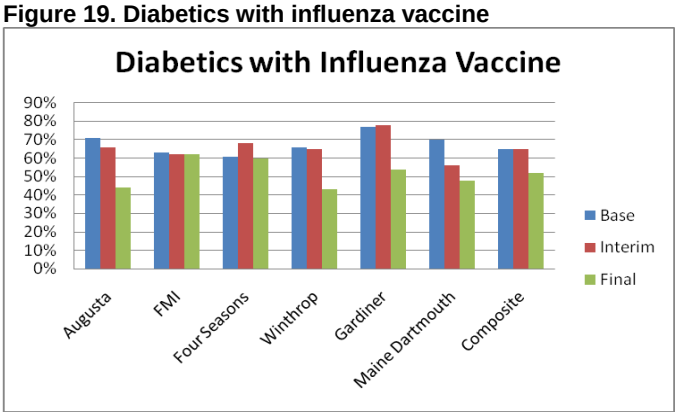
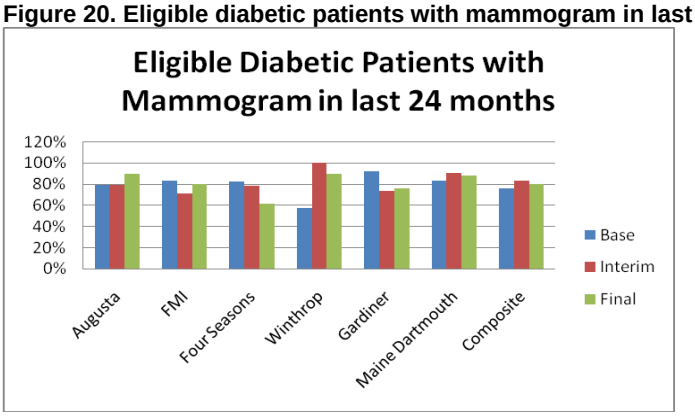


Figure 19. Diabetics with influenza vaccine



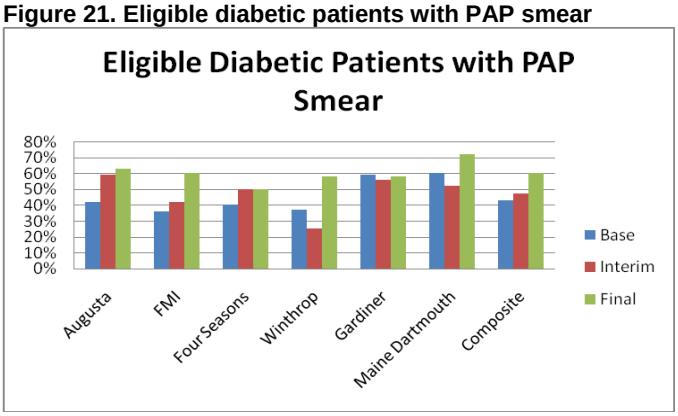
Mammogram During a 24-Month Period. The composite improvement for mammography screening from Baseline to Final Review (76% to 80%) although modest, defied the decline in rates nationwide (2000-2005) from 76.4% to 74.6%. There were, however, declines in mammography screening noted at three sites and no change at a fourth.

Figure 20. Eligible diabetic patients with mammogram in last 24 months



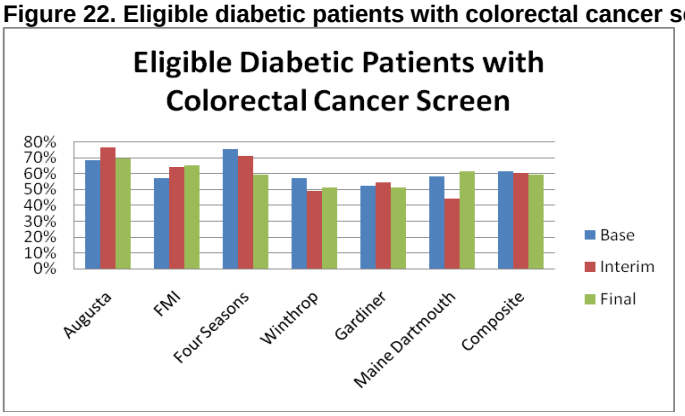
Pap Screening During a 36-month Period. Pap screening improved from Baseline to Final Review at all sites save one site that remained unchanged. The aggregate improvement was 17%.

Figure 21. Eligible diabetic patients with PAP smear



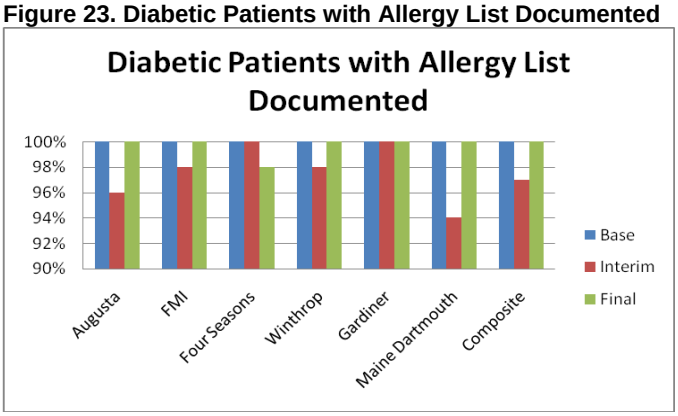
Colorectal Cancer Screening. In the aggregate, this measure remained unchanged. In addition, evidence of colorectal cancer screening was found almost exclusively in the paper record (70%).

Figure 22. Eligible diabetic patients with colorectal cancer screen



Allergy Screening. Allergy screening data was found in all instances (100% at all but one site) in the EMR during the Final Phase Review.

Figure 23. Diabetic Patients with Allergy List Documented



Domain 3: Patient Access to Care

3a: Panel Size by Provider/Site. Panel size is a function of the number of visits per patient per year and the visit per year capacity of an FTE physician. Calculations based on the two graphs to the right, assuming 1500 office hours per year for an FTE physician show a drop in calculated panel size from 1042 per doctor in Q3 2002 to 1029 patients per doctor in Q1 2008.

Figure 24. Visits per patient year

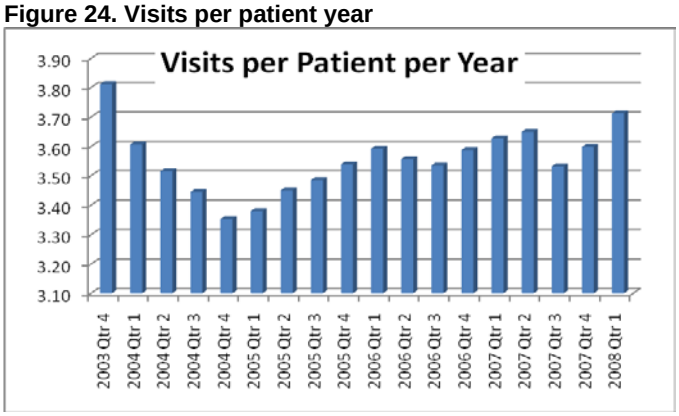
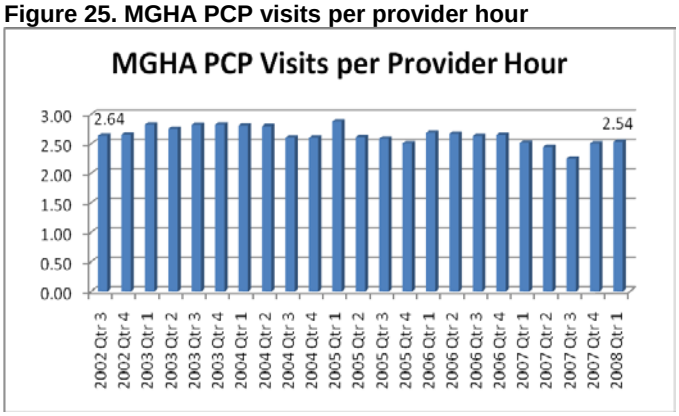


Figure 25. MGHA PCP visits per provider hour

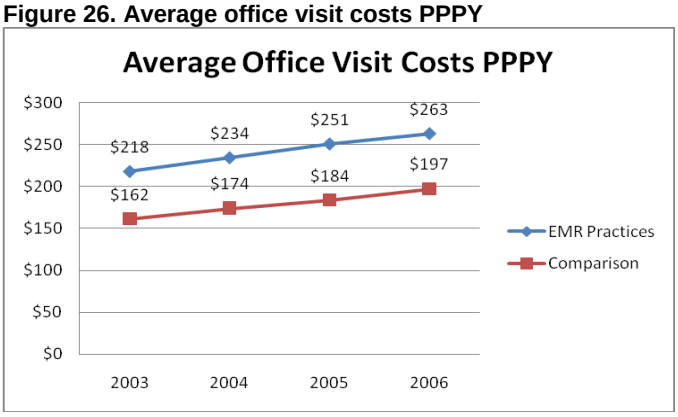


3b: Patient Visit Volume. The enterprise-wide volume of visits per patient dipped during initial implementation, but revoked over the period.

Domain 4: Costs

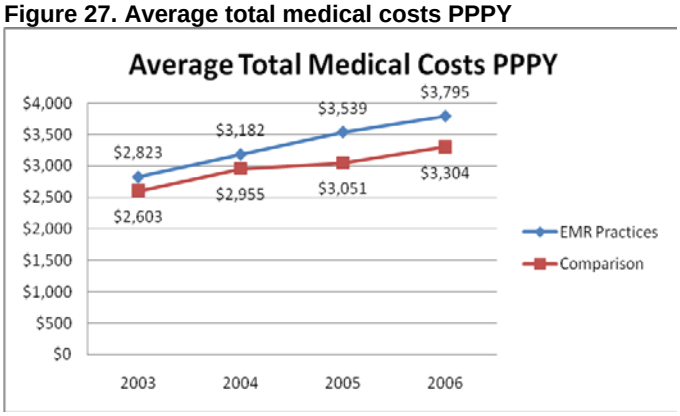
4a: Per Patient Per Year (PPPY) Outpatient Medical Costs/Claims. The dollars expended on the behalf of patients for primary care services was higher for patients seen by primary care physicians in the study group than by physicians elsewhere. The relative cost remained unchanged throughout the measurement years.

Figure 26. Average office visit costs PPPY



4b: PPPY Total Medical Costs/Claims. The dollars expended on the behalf of patients for all medical services was higher for patients seen by primary care physicians in the study group than by physicians elsewhere. The total cost of care rose at a steady rate for patients of the study group while the rate of rise slowed between 2004 and 2005 in the control groups, intensifying the difference in cost by the last of the measurement years.

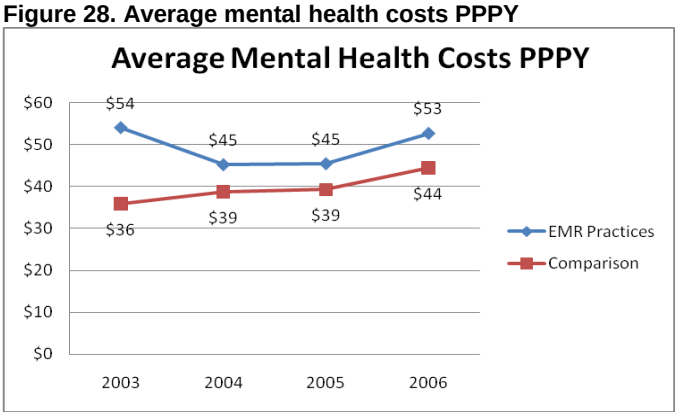
Figure 27. Average total medical costs PPPY



4c: PPPY Psychiatric Costs/Claims. The dollars expended on the behalf of patients for behavioral health services was higher for patients seen by primary care physicians in the study

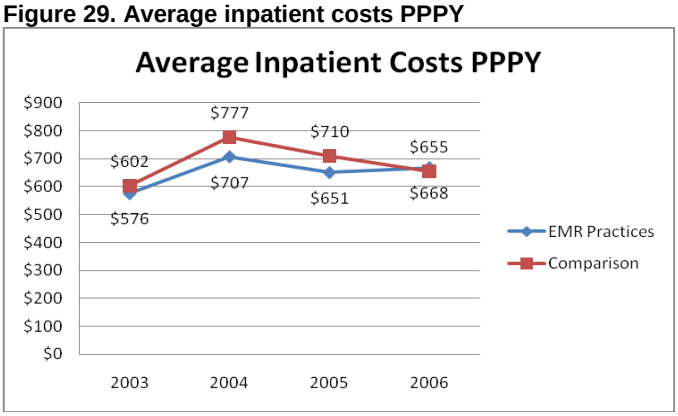
group than by physicians elsewhere. There was a dramatic decrease in costs in the study practices between 2003 and 2004 that was not seen in the control practices. Costs rose at a similar rate in both groups through the rest of the measurement years.

Figure 28. Average mental health costs PPPY



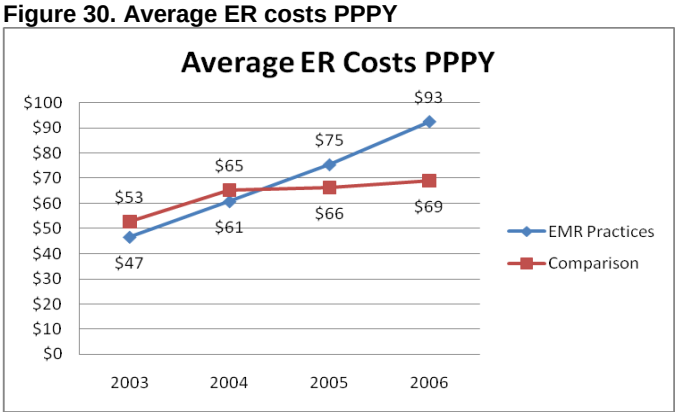
4d: PPPY Hospital Costs/Claims. The dollars expended on the behalf of patients for hospital services started lower for patients seen by primary care physicians in the study group than by physicians elsewhere. Annual changes paralleled each other until 2006 when costs for the study group rose while costs for the control group dropped making inpatient costs nearly equal.

Figure 29. Average inpatient costs PPPY



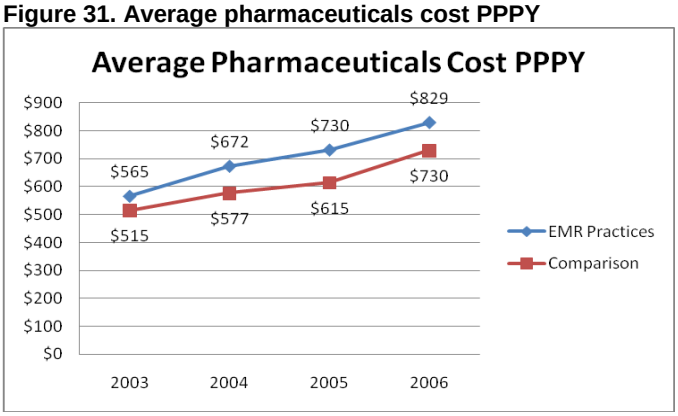
4e: PPPY ED Costs/Claims. The dollars expended on the behalf of patients for emergency room services began lower but ended much higher for patients seen by primary care physicians in the study group than by physicians elsewhere.

Figure 30. Average ER costs PPPY



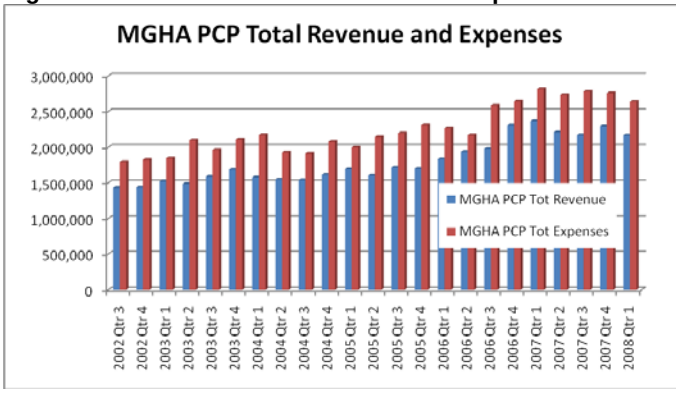
4f: PPPY Pharmacy Costs/Claims. The dollars expended on the behalf of patients for all pharmaceuticals was higher for patients seen by primary care physicians in the study group than by physicians elsewhere. The total cost of care rose faster for patients of the study group than in the control group intensifying the difference in cost by the last of the measurement years.

Figure 31. Average pharmaceuticals cost PPPY



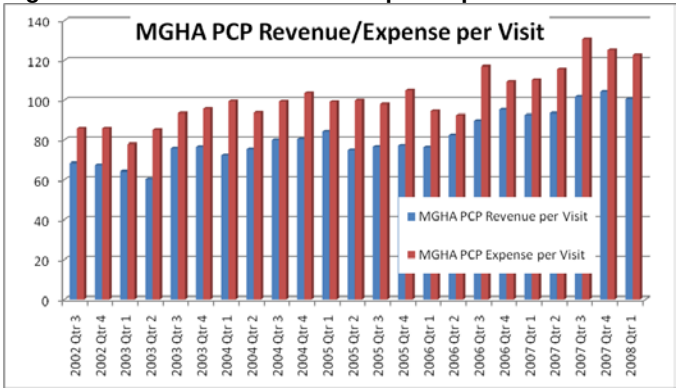
4h/i: Practice Expense and Revenue Reports. Revenue and expense data was available for our MGHA participating practices but was not made available from our residency practices.

Figure 32. MGHA PCP total revenue and expenses



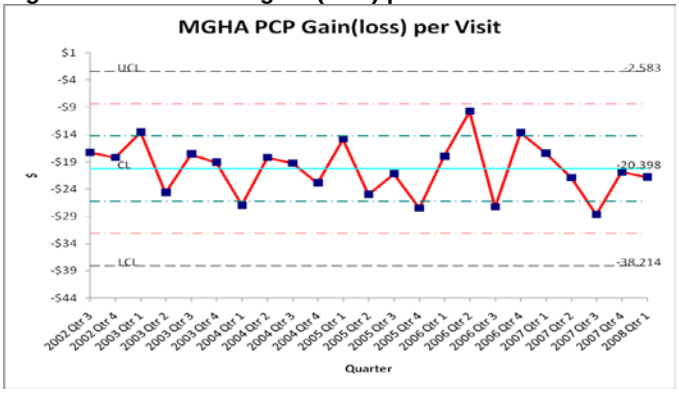
Revenue and expenses grew, seemingly, proportionately through the project period, whether measured in aggregate, or calculated as revenue per patient visit and expense per patient visit. In fact, converting the per visit revenue-expense figures to a Gain(loss) analysis in a XmR type flowsheet shows no evidence of special cause variation in practice gain(loss) through the project period.

Figure 33. MGHA PCP revenue/expense per visit



Costs of EMR were budgeted and paid by MaineGeneral outside the practice budget and accounting systems. The cost of EMR in the MaineGeneral system is additive to the costs outlined above and calculates to $18,000 per clinician, $26 per active patient, or $10 per patient visit.

Figure 34. MGHA PCP gain (loss) per visit



Outcomes

- *Implementation process:* We built an implementation team and process that is reproducible and has achieved EMR implementation without measurable loss in productivity.

- *Physician Engagement:* We have engaged the medical community as evidenced by 30 participating practices and 12 more in the implementation queue at the end of the grant period.

- *Sustainability* is achieved: In the final grant year MaineGeneral encountered significant budget challenges and chose to freeze efforts on EMR. Budget has been decreased sufficient to support current users and functionality but no funds will be expended to advance functionality or to expand participation. There is no evidence that deinstallation at current sites is likely and advancement efforts are likely to resume when budget issues are resolved.

- *Safety* is presumed to be improved: This appears to have been successful. It has proven difficult to collect metrics that prove that safety has been changed. Several successes of this project can be reasonably expected to enhance patient safety: Electronic prescribing is utilized nearly 100% of the time with its attendant legibility advantages and automated safety checking. Patient data including medication lists, allergy list, and problem lists is accessible to the physician on call, to emergency room staff, and to hospital admissions staff.

- *Quality* improvement has been equivocal.

- *Access* is marginally worsened.

- *Cost to the patient* increased for all patients during the study period, but increased more for patients in EMR practices than in the control group. Increased costs were primarily driven by emergency room and pharmaceutical costs.

- *Practice financial performance* is worsened.

Discussion

Implementation Process. We debated assigning staff in each office to take on the primary task of supporting EMR. Instead, we provided the bulk of staffing for training and support in a centralized fashion. Implications include: attribution of costs, ability to disseminate new functionality, standards, and processes, teamwork and access to training and support in the practices.

Physician Engagement. With some notable exceptions, we found physicians hard to engage proactively. Interest was sporadic, attendance and engagement was poor, understanding and functional solutions were elusive. In contrast, once we were in the midst of rollout, it far easier to bring clinicians and staff into groups to discuss and solve problems. Understanding was generally reached quickly, though agreement was often hard to reach.

Sustainability. Three factors heavily influenced sustainability. The first was the local perception of satisfaction. Early in the project when users were inexperienced and frustrated, the rest of the medical staff projected skepticism and reluctance about the utility of the project. As we developed a cadre of experienced and confident users who were able to serve as mentors and role models for others, the perception of value and willingness to participate grew in a geometric fashion. Second was a reversal of attitude by MaineGeneral senior leadership. Early in the project, there was an overall expectation that MaineGeneral could partially fund the implementation for owned practices by reselling licenses and implementation services to independent practices. However, the first independent practice to consider participating chose to implement a different EMR unconnected to any local projects. With the EMR implementation, they received a free interface to a national reference lab and moved their outpatient laboratory referrals from MaineGeneral to the national reference lab. The laboratory revenues lost to MaineGeneral dwarfed the cost of EMR. Third, new safe harbors in Stark and Antikickback regulations were unveiled during the project years. MaineGeneral realized that the EMR was a powerful tool to encourage utilization of local services and to improve integration and efficiency of the local healthcare system. As a consequence, MaineGeneral decided to use the new safe harbors to subsidize EMR use in private practices. Thereafter, 85% of licensing, implementation, and support costs for EMR were provided by MaineGeneral to the private practices. Once Maine General began covering these costs, we had very little difficulty recruiting private practices..

Safety. We chose not to deploy any measures of safety, judging that a credible process would have overwhelmed our resources. Future projects related to this implementation might include colleting patient self reports of adverse events, or collection of hospital discharge data that indicate admissions due to adverse ambulatory events. However, several aspects of this project can be reasonably expected to have enhanced patient safety, including the near-universal uptake of electronic prescribing and the availability of complete patient data across physician practices and in on-call and acute care settings.

Quality. Measurement of quality is typically not difficult. The difficulty we encountered in this project is a problem in the crossover from paper to electronic documentation. The chart

audit is the standard of quality measurement when records are in a paper chart. Auditing suffered from confusion of where the data should be. Aggregate reporting of each measurable item is the gold standard in an EMR. But we recognized in this early phase of EMR implementation, improvements in documentation will look the same in the reports as real improvements in quality.

Access. Access is a complex issue that encompasses issues of demand and capacity, convenience and barriers or hassles that decrease the likelihood of seeking care. We measured only the most basic parameter, capacity.

Cost. Cost to the patient was up 34% in participating practices, compared to 27% in control practices, over the measurement period. This difference appears to be primarily due to increases in ER and Hospital utilization and in pharmaceutical expenditures. ER costs rose 93%, and hospitalization costs rose 16% in participating practices compared to 30% and 9% in control practices. Pharmaceutical costs are up 47% in participating practices compared to 42% in control practices. The rise in ER costs is apparently a direct result of the implementation. Clinicians report that the EMR provided more accessible and more compelling data at each patient visit. They report that the EMR led them to provide more interventions for each patient at each visit. Each patient visit was more complex, more time consuming, and generated higher E&M billing codes. Consequently, they saw fewer patients overall. It makes sense that the displaced patients sought services in the ER instead. It also makes sense that more ER visits and reduced access to the primary care doctor leads to a higher rate of hospitalization. Increased pharmaceutical costs might reflect and track to either or both of the following: (1) accelerated rates and intensity of treatment to bring poorly controlled chronic diseases under control; (2) changes in prescribing patterns relating to increased ER utilization. We had no accessible metrics to track nonvisit care. We observed that there were no deliberate attempts in EMR practices to implement programs that would increase non-visit care, nor any credible observations that non-visit care was changed.

Practice Financial Performance. Participating hospital-owned primary care practices in the system continue to suffer a net loss on every patient visit, a dynamic that is seen almost universally in hospital owned primary care practices throughout the nation. The amount of measured net loss in MaineGeneral practices has not changed significantly through the project period. Compounding this observation is that most of the costs of EMR have not been factored into the cost accounting. Thus, stable gain/loss numbers translate to a net deepening of the loss equal to the cost of EMR.

Conclusions

Implementation of ambulatory EMR is a complex process. The project can be a technical success, can achieve clinician participation, buy-in, and engagement and still fail to deliver the expected performance or return on investment.

Significance

Broad dissemination of healthcare informatics in the United States is widely considered an important part of the national agenda to improve patient safety, increase quality of care, improve access to care, and contain healthcare costs. Projecting the costs of ambulatory EMR as experienced in the MaineGeneral environment to all physician practices in the U.S. yields an estimated annual cost in the vicinity of 10 billion dollars. We are at risk of concluding that ambulatory EMR does not and cannot work. We are at risk of bankrupting practices, straining health system resources, driving physicians out of practice, and increasing the rate of rise of healthcare costs through expensive ambulatory EMR implementations that fail to deliver desired effects. Identifying the factors that make ambulatory EMR implementation both efficient and effective can avoid waste, save money, and save lives.

Implications

Despite disappointments in performance in the MaineGeneral project, it still makes sense that ambulatory EMR has a foundational role in healthcare improvement in the United States and that there are factors not yet fully elucidated that will help to achieve goals. Future efforts could be directed at wide array of factors that are likely to be important, including: project factors, practice factors, network factors, and environmental factors.

Project Factors.

- Implementation sequence and pace: There appears to be a finite capacity for learning by the users. As users are mastering one content, they cannot attend to another. There is also likely to be an optimum sequence. Some functionality and skills are foundational for others. There is probably both an optimum pace and an optimum sequence of both implementation and learning and that yields the most cost effective results.

- Training Curriculum: Many implementation projects have a formal structure for initial training, but nothing formal beyond that. There may be opportunity to structure a long-term learning environment to shepherd each user to expert status. Such a program will take into account optimum sequence and pace, differing learning styles in the user community, might use data from the system to target specific groups of users with common learning needs, and might have a certification process.

- Project staffing: What is the optimum set of roles for the project staff? What roles and functions have to be provided to support ambulatory health IT and which of those functions is better centralized, and what is better decentralized? MaineGeneral made the decision to centralize training and support staff. But there might be better performance if each practice spread primary training and level 1 support roles amongst multiple practice staff members, increasing the likelihood that when any user had a question or need, that the appropriate resource was close at hand.

Practice Factors.

- Practice Transformation: Practices appear to go through a "Substitutive Phase" of EMR implementation in which an EMR is chosen for its ability to mimic traditional patient management processes and it is implemented in a way that substitutes electronic processes on a one to one basis for previous paper-based processes. It may not be until after the electronic tools are mastered that opportunities to transform care are recognized and implemented. There may be tools to help move more quickly into the "Transformative Phase" of EMR implementation that might help avoid costly retraining and reimplementation.

- Investment in training: Under-investment in training appears to be epidemic. New employees are often given a one to two week orientation after which they are substantially on their own. This pattern often holds true for all practice functions including EMR. New staff often takes a year or more to become efficient and effective members of the team. Increased investment of time and money in training new staff on all things including EMR may yield a dramatic return on investment.

- Practice Workflows are seldom carefully examined: Various improvement heuristics introduce techniques of process mapping, value stream mapping, reducing waste, reducing the number steps in each process, and reducing handoffs. Such careful consideration of all practice workflows in the EMR enabled practice may more quickly move the practice into the transformative phase.

- Practice Staffing: Practices implementing EMR need to be over-staffed. There are many factors that increase the workload on practice staff during implementation: Demand by patients for services continues unabated; every patient seems like a new patient requiring extra time to build the electronic problem list, allergy list, and medication list; some staff members will be taking on training and support roles for EMR; everyone needs to take time to learn and to practice the new systems; there will be unexpected consequences and the need for troubleshooting, and the mixed system where some data is in the EMR and some is in the paper chart is the most inefficient system of all. In addition, there needs to be time and attention given to staff turnover and for retraining and reassigning staff whose jobs are made obsolete by the EMR.

- Commitment to ROI: There seems to be a tendency to expect the efficiencies of EMR to occur passively or automatically on implementation. And there is a tendency for each person to expect and labor toward a personal view of "return on investment." In the MaineGeneral system, clinicians tended to focus on improving the quality of care and wanted to redeploy displaced medical records staff into more patient centered roles. Practice management wanted to reduce staffing expenses and tried to reduce medical records staff reflexively as implementation progressed. The resultant chaos might have been averted with a more deliberate approach to return on investment. Agree up front on the priorities. Understand the pre-requisites, such as the need for scanning before we can be paperless, and the need for paperlessness before we can redeploy or reduce medical

records staff. Agree on a rational sequence and pace of implementation. And actually commit as a group to labor to achieve the desired results.

- Alignment of leadership efforts: Organizational techniques to increase the rate and extent of alignment are likely to be fruitful. A common source of chaos in the MaineGeneral implementation was tacit permission from senior leadership for various functional units to opt out of automation.

Network Factors.

- Centralized services: The ability to access data from a central location, and the complexity of dealing with emerging technical solutions and regulations argues for a set of tasks that may be more cost effective to deliver from and centralized standpoint. Such services might dramatically improve the cost effectiveness of EMR implementation. Such services might include: releasing medical records, scanning and indexing new mail and received medical records, processing outgoing mail, delivering patient reminders, deduplicating patients, working interface errors.

- Learning communities: The pace of practice transformation may be enhanced by building these projects around learning communities. In a learning community on either a shared IT infrastructure or robust data exchange, data can be used to identify best practices. Cross practice visitation and collaborative training efforts can help to disseminate best practices.

- Level of Participation: There may be a necessary threshold of participation. Before the threshold is reached, dissemination is inefficient and ineffective. After the threshold is reached, it becomes a self-potentiating process and interest in participation thereafter increases geometrically.

- Improvement heuristic: There are a number of heuristics in use to help systems of any kind improve their efficiency and effectiveness. Health systems may improve efficiency and effectiveness using advanced information systems in concert with tools such as Clinical Microsystems, Lean, Six Sigma, and Total Quality Management to both improve each practice in the system and to integrate workflows as patients move between practices.

- Pooled resources: Implementation and use of an EMR is expensive and difficult. Healthcare in the community is a team effort. Success may be more likely if we pool resources to implement, use, and improve, these systems across communities. There may be an optimum size to the effort.

- Marketing and Communication: How we communicate, what we communicate, and how much we communicate are critical. Honesty, brevity, enthusiasm, confidence, and a variety of media are all likely to make a difference.

Environmental Factors.

- Time: It may be that we are already doing exactly the right thing at exactly the right pace and that more time and patience are required to deliver on the expectations of health IT.

- Regulatory Changes: Ambulatory EMR is substantially about care management and population management. But regulations and payment traditions and still favor acute care and one on one face to face visits with the doctor chronic disease management and population based care. It may be that we will see more of the efficiencies and effectiveness that we seek when regulatory and payment reforms are delivered.

List of Publications and Products

Mingle, D. Taking Care to the Community: Using the EMR to Initiate Health Practice Change. Annual Meeting; 15-Oct-04; Rye Brook, NY; Society of Teachers of Family Medicine.

Mingle, D. Taking Care to the Community: Using the EMR to Initiate Health Practice Change. Maine Quality Forum Advisory Group; 11-Mar-05; Augusta, ME; Maine Quality Forum.

Mingle, D. Taking Care to the Community: Using the EMR to bring the Right Care at the Right Time to Every Person in the Kennebec Region. IT Steering Committee; 09-May-05; Augusta, ME; MaineGeneral Health.

Mingle, D. MaineGeneral and the Abreon Group: Partnership for a Successful Rapid Roll Out. Allscripts Customer Experience; 19-May-05; Chicago, Il; Allscripts Healthcare Solutions.

Mingle, D. EHR Roll Out, Learning from the MaineGeneral Experience. Annual Patient Safety and Health Information Technology Conference; 07-Jun-05; Washington, DC; AHRQ.

Mingle, D. EMR Implementation progress report. Practice Administrator's Group; 14-Jun-05; Augusta, ME; Maine Hospital Association.

Mingle, D. Interconnecting the MaineGeneral Community. Hanley Trust Health Forum; 17-Jun-05; Brunswick,ME; The Hanley Trust.

Mingle, D. Taking Care to the Community. Medical Staff Meeting; 21-Jul-05; Augusta, ME; MaineGeneral Health.

Mingle, D. Interconnecting the MaineGeneral Community. IT Workgroup Meeting; 10-Aug-05; Augusta, ME; HealthReach Community Health Centers.

Mingle, D. Taking Care to the Community. IT Division Meeting; 17-Aug-05; Augusta, ME; MaineGeneral Health.

Mingle, D. Using the EHR, to Strengthen the Collaboration between Providers and Community Resources for Diabetes Care. Annual Meeting; 07-Sep-05; Augusta, ME; Maine Diabetes and Control Project.

Mingle, D. Taking Care to the Community. Tech Talks; 15-Sep-05; Augusta, ME; Maine Medical Association.

Mingle, D. Implementing an EMR to Stimulate Practice Change in a Rural Health System. Northeast Region Annual Meeting; 12-Oct-05; Hershey, PA; Society of Teachers of Family Medicine.

Mingle, D. Using the EMR to bring the right care at the right time to every person in the Kennebec Region. MaineHealthLink Physician Work Team; 22-Oct-05; Portland, ME; MaineHealth.

Mingle, D. The Idiot's Guide to Implementing and EHR, Lessons from MaineGeneral. Medical Staff Meeting; 17-Nov-05; Skowhegan, ME; Reddington-Fairview Hospital.

Mingle, D. How to Implement EMR. EMR Kickoff Meetign; 15-Feb-06; Augusta, ME; HealthReach Community Health Centers.

Mingle, D. The Foundational Role of EHR in a Successful RHIO, Lessons from Rural Maine. Annual HIMSS Conference; 16-Feb-06; San Diego, CA; HIMSS.

Mingle, D. Best Practice Implementation Methodologies. Allscripts Customer Experience; 21-Apr-06; Chicago, Il; Allscripts Healthcare Solutions.

Mingle, D. The Electronic Record and Practice Redesign as a cure to the Common Crisis in Healthcare. Selected Legislators on Capital Hill; 13-Jun-06; Washington, DC; HIMSS.

Mingle, D. EMR Implementation progress report. Practice Administrator's Group; 19-Sep-06; Augusta, ME; Maine Hospital Association.

Mingle, D. One Person – One Chart, Uniting Our Medical Community to Bring the Right Care at the Right Time to Every Person in the Kennebec Region. IT Steering Committee Meeting; 13-Nov-06; Augusta, ME; MaineGeneral Health.

Mingle, D. The Idiot's Guide to EHR, Lessons from MaineGeneral. Annual Meeting; 08-Dec-06; Portland, ME; Maine Health Information Management Association.

Mingle, D. What to Consider when you are Considering ePrescribing. Brinkman Physicians in Rural Practice Symposium; 23-Mar-07; Farmington, ME; Franklin Community Health Network.

Mingle, D. Interoperability: Will RHIOs Really Make a Difference in Patient Care? Allscripts Executive Track; 21-Apr-07; Chicago, Il; Allscripts Healthcare Solutions.

Mingle, D. Will RHIOs Really Make a Difference in Patient Care? TEPR; 22-May-07; Dallas, Tx; Medical Records Institute.

Mingle, D. Ambulatory EMR, CHR, and Touchworks. VHA New England Physician Executive Council; 15-Jun-07; Portland, ME; VHA.

Mingle, D. Analytics, A Comprehensive Workshop. Allscripts Customer Experience; 01-Aug-07; Chicago, Il; Allscripts Healthcare Solutions.

Mingle, D. Pay for Performance and Ambulatory Outcomes. Allscripts Customer Experience; 02-Aug-07; Chicago, Il; Allscripts Healthcare Solutions.

Mingle, D. Analytics, How it's Changed the Way we do Business. Allscripts Customer Experience; 03-Aug-07; Chicago, Il; Allscripts Healthcare Solutions.

Mingle, D. New Reimbursement Approaches and Opportunities. Allscripts Customer Experience; 03-Aug-07; Chicago, Il; Allscripts Healthcare Solutions.

Mingle, D. Will Ambulatory EHR Make a Difference in Patient Care? AHRQ Annual Meeting; 11-Sep-07; Bethesda, MD; AHRQ.

Mingle, D. Clinical Data, Successes and Barriers in the Flow of Data, From Documentation to Utilization. Quality Counts 5; 05-Dec-07; Augusta, ME; Maine Quality Counts.

Mingle, D. Ambulatory EMR at MaineGeneral. Allscripts Service and Support Meeting; 14-Jan-08; Burlington, Vt; Allscripts Healthcare Solutions.

Mingle, D. Using Technology to Assist your Practice. 17th Annual Practice Education Seminar; 28-May-08; Augusta, ME; Maine Medical Association.

Mingle, D. The Role of Stark Reform in the Transformation of Healthcare in Rural Maine. HIMSS Summit; 09-Jun-08; Washington, DC; HIMSS.

Mingle, D. Ambulatory EHR. Allscripts Executive Summit, 09-Jul-08; Chicago, Il; Allscripts Healthcare Solutions.

Mingle, D. EHR Implementation and Adoption. AHRQ Annual Meeting; 09-Sep-08; Bethesda, MD; AHRQ.