

# A Partnership for Clinician EHR Use and Quality of Care

## Final Progress Report

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## Structured Abstract

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**Purpose:** The purpose of this project was to study the effectiveness of a partnership model to promote full use of an electronic health record (EHR) by clinicians in settings that serve vulnerable populations, in order to improve the quality of care in the areas of preventive care, chronic disease management, and medication management.

**Scope:** This study explored the challenges to adopting EHRs in safety net practices including Nurse Managed Health Centers (NMHCs) and Federally Qualified Health Centers (FQHCs). The goals included: helping centers assess their organizational readiness for EHR; fostering vision, incentive, resources, skills, and action plans; and providing guided implementation through a partnership with the Alliance of Chicago (Alliance). We evaluated clinician full use and barriers to use, clinician satisfaction with EHR, quality of care, and patient experience.

**Methods:** The research design incorporated quantitative and qualitative methods as well as individual and center level analyses. Data were collected and analyzed using a longitudinal design. NMHCs went live during the study, allowing for comparison of pre and post data. Alliance sites went live prior to the study so their data were not expected to show trends but instead served as a benchmark.

**Results:** The project demonstrated that careful EHR implementation in a model of sustained partnership focusing on the quality of EHR use by clinicians had a positive impact on quality of care and experience of care by clinicians. We found that ongoing partnership support of centers facing significant implementation barriers can lead to successful outcomes.

**Key Words:** Electronic health records, Nurse managed health centers, Community health centers, Quality, Vulnerable populations, Patient safety, User acceptance, Clinical decision support, Effectiveness evaluation

## Purpose (Objectives of Study)

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The “Partnership for Clinician EHR Use and Quality of Care” convened an experienced team in a unique partnership between the Institute for Nursing Centers (INC) and Alliance, with participation from both Community Health Centers (CHCs) and NMHCs. Our specific aims were: To study the effectiveness of a partnership that shares resources and utilizes a data driven approach to promote full use of an EHR system by clinicians in settings that serve vulnerable populations, in order to improve the quality of care in the areas of preventive care, chronic disease management, and medication management.

The objectives were accomplished through the following:

### Project Goals and Research Questions

- 1) Testing the links between clinician use of an EHR and quality of preventive care, chronic disease management, and medication safety:
  - a. How does clinician use of an EHR impact patient outcomes for preventive care (tobacco use/advice, cervical cancer screening, HIV screening, depression screening, and adult immunizations), hypertension, and diabetes?
  - b. What are the longitudinal patterns of clinician use of an EHR related to these outcomes?
  - c. What are the medication errors that occur in ambulatory settings? How does clinician use of an EHR impact medication safety?
  - d. How does the use of an EHR affect clinical productivity?
  - e. How do clinician characteristics (gender, age, clinician type, computer literacy) impact EHR use?
  - f. What is clinician satisfaction with the EHR?
- 2) Examining organizational processes in the implementation and full utilization of an EHR in relationship to care delivery and outcomes:
  - a. Do center practices related to patient safety improve over time with increasing clinician EHR use?
  - b. What contextual factors (i.e., leadership, vision, skills, incentives, resources, and planning for change management) impact clinician use of EHRs?
  - c. What is the variation in how centers use/take advantage of partnership support during implementation, workflow redesign, and ongoing support for clinician use of CDS and medication management features?

## Scope

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### **Background**

Although EHRs have been proposed as a solution to quality care, in practice they have not consistently lived up to expectations. This study explored the challenges to adopting EHRs in safety net practices including NMHCs and FQHCs. The project’s goals were to help these centers assess their organizational readiness for EHRs; to foster

vision, incentive, resources, skills, and action plans; and to provide guided implementation through an industry partnership with Alliance. We evaluated clinician full use and barriers to use, clinician satisfaction with EHR, quality of care, and patient experience. Full, complete and standardized use of an EHR must be a matter of policy of the particular practice or agency. We believe – and the literature seems to support – that partnership resources can be provided to support a variety of organizations in this effort. That said, the quality of clinician use of EHR has the potential to vary across organizations and individuals. To ensure patient safety and access to data for quality assurance and continuous quality improvement, core elements of the EHR must be used and act as the guide for evaluating complete adoption of the EHR. Our project examined how this data-driven partnership model addressed the challenges of full use of EHRs by clinicians (physicians, NPs and midwives) in diverse settings serving vulnerable populations and how clinical decision support was used to achieve gains in patient safety, specifically related to medication prescribing and quality of care. To the extent that variation exists across individuals and centers in EHR use and quality outcomes, the source of this variation will be better understood.

**Context**

INC is a national network of key stakeholders committed to the development and promotion of NMHCs that increase access to primary health care and respond to communities’ needs and target historically underserved populations. It functions to maintain the National Data Warehouse for NMHCs, inform policy to promote NMHCs as a viable health care option, and develop and market educational and business products and services. INC is housed at the Michigan Public Health Institute (MPHI), a private non-profit health research institute in Michigan.

INC partnered with Alliance to provide a web-based Practice Management (PM) and EHR service along an Application Service Provider (ASP) model in which Alliance served as the ASP. Alliance is a network of four FQHCs serving primarily low-income and uninsured patients with multiple, complex needs in the Chicago area. While formed initially in 1997 in response to the need to ensure managed care readiness and contracting, joint clinical services and health education for its members, Alliance has evolved into an entity that provides infrastructure to support clinical quality improvement and the technology and implementation of an EHR for health centers across the nation.

INC and Alliance worked with General Electric (GE), a major EHR vendor, to offer centers the Centricity combined PM/EHR software at a reduced cost. Alliance and INC acted as the central purchaser and negotiator for software and hardware. This model allowed sites to receive training and support from partnership (rather than vendor) staff for EHR implementation, as well as associated workflow redesign and customization of clinical decision support in templates developed by Alliance. Alliance chose and optimized Centricity, equipped with robust functionality that meets federal certification for ‘meaningful use.’ This functionality includes quality and financial benchmarking, clinical decision support, medication safety and e-prescribing functionality, fully functional on-line clinician order entry and referral management, comprehensive patient education content, registry for population health management and quality reporting for Meaningful Use, PQRI, and Health Disparities Disease Collaboratives.

**Settings**

The participating health centers included three CHCs/FQHCs affiliated with Alliance and four NMHCs (one of which is also an FQHC) affiliated with INC. The NMHCs were selected based on a standardized readiness assessment completed by a neutral vendor. Center characteristics are outlined below:

**Table 1. Center Characteristics**

Center name	Location	Center type	Annual visit volume	Population served	Type of care
Glide Health Services (GHS)	San Francisco	NMHC & FQHC	13,000	Urban, homeless Financially disadvantaged	Primary Care, Mental Health, HIV testing & risk reduction
Campus Health Center of Detroit	Detroit, MI	NMHC	9,000	Wayne State University Students, Staff, Families	Primary Care

Center name	Location	Center type	Annual visit volume	Population served	Type of care
Arizona State University (ASU)	Phoenix, AZ	2 NMHCs	7,000 +	Urban, Financially Disadvantaged	Primary Care, Mental Health, HIV testing & risk reduction
Howard Brown Health Center	Chicago	CHC FQHC	>10,000 medical visits	Urban, HIV + Gay, Lesbian, Bisexual, Transgender	Primary Care, Mental Health & Substance Abuse
Erie Family Health Center – West Town	Chicago	CHC FQHC	>42,000 medical visits	Urban, Hispanic and Recent Mexican & Puerto Rican	Primary care, OB/GYN, Internal Medicine, Pediatric
Heartland Health Outreach (HHO)	Chicago	CHC FQHC	>14,000 medical visits	Urban Homeless, Migrant, Recent Refugee	Primary Care, Mental Health, OB/GYN

### ***Participants***

Data were collected primarily at the level of clinician or clinic, though patient-level data were utilized in the form of site-collected anonymous patient satisfaction surveys. While clinician satisfaction surveys and EHR-derived data were only collected from billable providers (MDs, PAs, NPs), certain data items (qualitative interviews, PPPSA group surveys) involved non-clinician staff including site leadership, administrative staff, medical assistants, and nurses. See Table 2 below (Study Design and Measurement section) for numbers of participants.

## **Methods and Results**

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### ***Study Design and Measurement***

The research design incorporated quantitative and qualitative methods as well as individual and center level analyses. Data were collected and analyzed using a longitudinal design to examine the developmental pattern of clinician use of EHR and its temporal association with various performance, outcome, and medication safety measures. NMHCs went live during the course of the study, allowing for comparison of pre and post data. Alliance sites went live on EHR prior to the study so their longitudinal data were not expected to show trends related to go-live, and no pre-implementation or during implementation data were collected from these three CHCs.

A qualitative investigation, including surveys completed on-line by clinicians and face-to-face or phone interviews with clinicians and clinic staff, provided understanding of how EHR is used, what factors facilitate use, and what factors challenge successful and complete usage. Moreover, in order to ensure that the partnership model was generalized, a qualitative process analysis was undertaken. It is through qualitative analysis at the level of the health center, that the implementation process can be clearly documented. Table 2 summarizes the data collected in relation to the unit of analysis of the research question.

**Table 2. Data Collection and Design Overview**

Unit	Structure	Process	Outcomes
<p><b>Clinician</b>  <b>N=183</b>                      (207 including other staff)</p>		<p><b><u>Use of EHR</u></b>                      1) Self-Report: End-User Survey                      2) Query (all metrics reported as % of visits)  <ul style="list-style-type: none"> <li>• Visits with corresponding clinical note in EHR</li> <li>• Diabetes disease management form usage</li> <li>• Cardiovascular disease management form usage</li> <li>• E&amp;M advisor usage</li> </ul>   <b><u>Clinical quality process metrics</u></b>                      1) Appropriate preventive care  <ul style="list-style-type: none"> <li>• % Aged 50+ with Influenza Vaccination</li> <li>• % Aged 65+ with Pneumococcal Vacc</li> <li>• % with Smoking Status</li> <li>• % of Smokers With Cessation Intervention</li> <li>• % Women Aged 50-69 With Mammogram</li> <li>• % Aged 50+ Screened For Colorectal Cancer</li> <li>• Cervical Cancer Screening (HRSA Core)</li> <li>• Depression Screening (HDC)</li> <li>• Tetanus/Diphtheria vaccination (CDC)</li> <li>• % With LDL</li> <li>• % Visits with BP</li> </ul>                       2) Diabetes management (HRSA Health Disease Collaborative measures)  <ul style="list-style-type: none"> <li>• % visits with BP value</li> <li>• % visits with BP value</li> <li>• % with Eye Exam</li> <li>• % with Foot Exam</li> <li>• % with Dental Exam</li> <li>• % with Microalbumin Test</li> <li>• % with Depression Screening</li> <li>• % who Exercise 3+ times/week</li> <li>• % with Influenza Vaccine</li> <li>• % with 2 HbA1c values in last yr (3+ mths apart)</li> <li>• % with HbA1c value</li> <li>• % assessed for smoking status</li> <li>• % documented as current smokers</li> <li>• % smokers offered cessation intervention</li> <li>• % taking ACE Inhibitor or ARB</li> <li>• % taking Statins</li> <li>• % taking Aspirin or Antithrombotic</li> <li>• % with Self-management Goal</li> </ul> </p>	<p><b><u>Experience of care</u></b>                      1) Self-Report: End-User Survey  <ul style="list-style-type: none"> <li>• Enjoyment of practice</li> <li>• Perceived effect on quality &amp; safety</li> <li>• Overall satisfaction</li> </ul>   <b><u>Clinical quality outcome metrics</u></b>                      1) Diabetes  <ul style="list-style-type: none"> <li>• % with Last BP&lt;140/90 (DOQ-IT)</li> <li>• % with Last HbA1c &gt; 9.0 (DOQ-IT)</li> <li>• % with Last HbA1c &lt; 7.0 (DOQ-IT)</li> <li>• % with BP&lt; 130/80</li> <li>• % with LDL&lt;100</li> <li>• Average HbA1c</li> </ul>   <b><u>Productivity</u></b>                      1) Encounters/FTE                      2) RVUs/FTE</p>
<p><b>Clinic</b>  <b>N=7</b></p>	<p><b><u>Policies and Procedures</u></b>                      1) Physician Practice Patient Safety Assessment</p>	<p><b><u>Key Informant Interviews</u></b>                      1) Conducted at three times (before, during, after implementation) at NMHCs, once at CHCs  <ul style="list-style-type: none"> <li>• Change management</li> <li>• Partnership support</li> </ul> </p>	<p><b><u>Medication Safety</u></b>                      1) Documentation of alerts received during pre-load                      2) Query for co-occurrence of drug-drug interaction (DDI) pairs</p>
<p><b>Patient</b>  <b>N=347</b></p>			<p><b><u>Patient Experience</u></b>                      1) Satisfaction survey developed by INC</p>

### ***Intervention: The Partnership Model of EHR Implementation and Support***

In the project, we used a partnership model to facilitate the endeavor to implement EHR systems in nurse-managed settings. The model was jointly developed by the investigator team and Alliance Chicago based on the following three premises: (1) an engaging and sustaining relationship with the technology team is the only way to shield healthcare practices from adoption difficulties and uncertainties (i.e., partnership-based); (2) adopting practices should think and act collectively as a community in order to lower purchase and maintenance costs and jointly develop best practices for implementation and use (i.e., community-oriented); and (3) it is central to have strong commitments by all parties to managing EHR implementation as a long-term, continuous quality improvement (CQI) process, as opposed to a one-time software installation effort.

The model, as its name suggests, placed a prominent focus on building a strong and long-lasting collaborative relationship between EHR implementers and adopting healthcare practices. As a matter of fact, the technology group of the partnership, Alliance, was initially created by a network of federally qualified health centers to plan and establish a shared technology infrastructure to serve their common needs. Such needs include not only implementing electronic systems to support routine clinical data acquisition and management, but also (1) advocating on their behalf to compete for resources from parent organizations, affiliated physician consortiums and extramural funding agencies; (2) negotiating with external partners (e.g., affiliated hospitals and outpatient laboratories and pharmacies); and (3) creating a community-wide analytical data warehouse for secondary-use purposes such as quality improvements and research. Over the past few years, Alliance has also evolved into a technology consulting group providing EHR implementation services to new members of the partnership - at a much more affordable price subsidized by both federal grants and cost sharing among all participating centers. In essence, the 'EHR implementer' of the partnership grew from the community, supported by the community, and serves the community, rather than being brought in as a temporary, third-party IT contractor.

Furthermore, the partnership model placed a particular emphasis on fostering a collaborative culture among all participating healthcare practices to facilitate information and experience sharing. The objective was to leverage the partnership's collective wisdom so as to reduce redundant effort (e.g., by the shared use of common disease management templates and decision-support tools), as well to jointly identify solutions to common adoption barriers and post-implementation adaptation difficulties. This peer cooperation was achieved through periodical leadership teleconferences and an annually convened in-person partnership symposium. The partnership also encouraged the community to document and share their EHR implementation knowledge and stories.

Finally, CQI served as a key guiding principle of the partnership model because none of the EHR implementation processes are discrete and can be optimized independently. Additionally, emerging conditions brought with or magnified by later processes often invalidate previous assumptions, thus requiring an iterative approach. This approach needed to incorporate not only the initial assessments (we used the analysis of strengths, weaknesses, opportunities and threats; SWOT),<sup>1</sup> but also CQI methods including formative evaluation, constant performance feedback and timely implementation of corrective actions (based on the Shewhart /Deming cycle of plan, do, check, and act).<sup>2</sup> Therefore, establishing strong commitments by all parties involved to managing EHR implementation as a long-term project, rather than a one-time software installation effort, is foremost crucial.

An important component of the partnership model was an EHR planning and implementation guideline (PM-PIG), which was designed to facilitate consensus development between the technology team and the participating healthcare practices and strategic planning and task execution in each of the key implementation phases. The guideline was largely informed by the notion of mindful innovation with IT proposed by Swanson and Ramiller,<sup>3</sup> which conceptualizes that an organization's journey toward mindful adoption of a technological innovation must undergo four essential steps: comprehension, adoption, implementation, and assimilation, with an analysis of common pitfalls caused by 'mindlessness' in each step. In Table 3, we provide an outline of its 19 key components organized into three distinct implementation phases, before (comprehension and adoption), during (implementation) and after (assimilation). Note that while the post-implementation activities usually start 3 months after the initial 'go-live' date, there is no definitive time divide between the during and the post phase. The during implementation activities could last as long as it takes if the needs persist, e.g., unexpected technical or user acceptance issues that may continue to emerge.

<b>Pre-implementation</b>	<b>During Implementation</b>	<b>Post-Implementation</b>
<ul style="list-style-type: none"> <li>• Readiness assessments</li> <li>• Technical infrastructure preparation</li> <li>• Culture preparation and change management</li> <li>• Workflow redesign</li> <li>• Guided data preloading</li> <li>• Software tailoring</li> <li>• Integrated and upgraded billing</li> <li>• Data exchange capability</li> <li>• Assistance in negotiation and working with external partners</li> </ul>	<ul style="list-style-type: none"> <li>• Shared hosting</li> <li>• Training and retraining</li> <li>• Formative evaluation</li> <li>• Regular performance feedback</li> <li>• Corrective actions</li> </ul>	<ul style="list-style-type: none"> <li>• Leadership teleconference</li> <li>• Annual partnership symposium</li> <li>• Data integrity</li> <li>• Centralized analytical data warehouse</li> <li>• Research capacity building and summative evaluation</li> </ul>

## **Results**

In this section we describe the development of each measure and summary findings in more detail.

### Clinician Experience

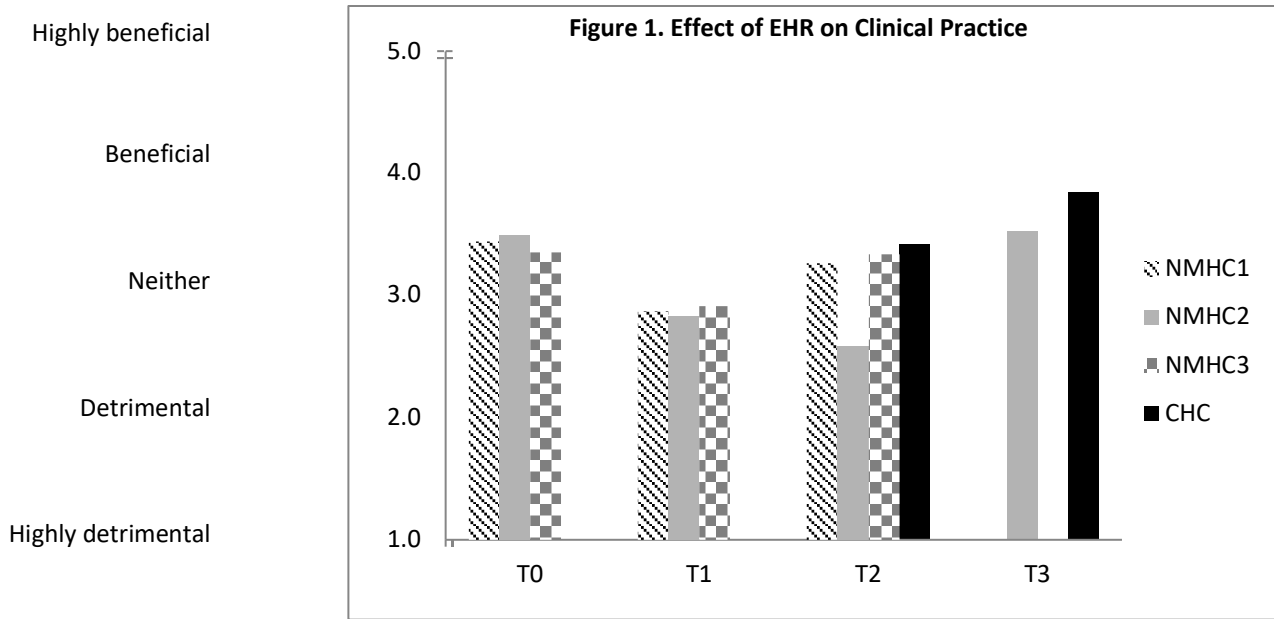
Clinician experience was measured by the tool developed by the research team and implemented at two time points. These time points corresponded to ‘during implementation’ (T1 – about 3 months post go-live), and post implementation (T2 – 6-13 months post-go-live) at the NMHCs. At the CHCs the survey was conducted at T2 (over 19 months post go-live) and T3 (2-3 years post go-live). In addition, because of a series of setbacks at NMHC2, which led to a prolonged implementation period, a third data collection point was added (T3) at 2 years post go-live for this center only. An additional survey was implemented at the NMHCs prior to go-live (T0). This survey assessed computer literacy and attitudes/expectations regarding the effect of ‘computers’ on clinical practice. The attitude scale was modified and included as an ‘impact of EHR’ scale in the clinician experience survey.<sup>4</sup>

To develop the Clinician Experience survey, the research team surveyed the literature but failed to identify a validated scientific instrument for assessing end-user perception of EHRs. Therefore, we synthesized relevant prior research in both the domain of health informatics and the domain of information systems research to develop a customized EHR end-user evaluation tool. As part of this project, we empirically validated the tool and refined it based on the results. The final instrument contains 5 sections and 19 questions, soliciting several key theoretical constructs including performance expectancy, effort expectancy, and facilitating conditions. A manuscript reporting the instrument development process is currently being prepared.

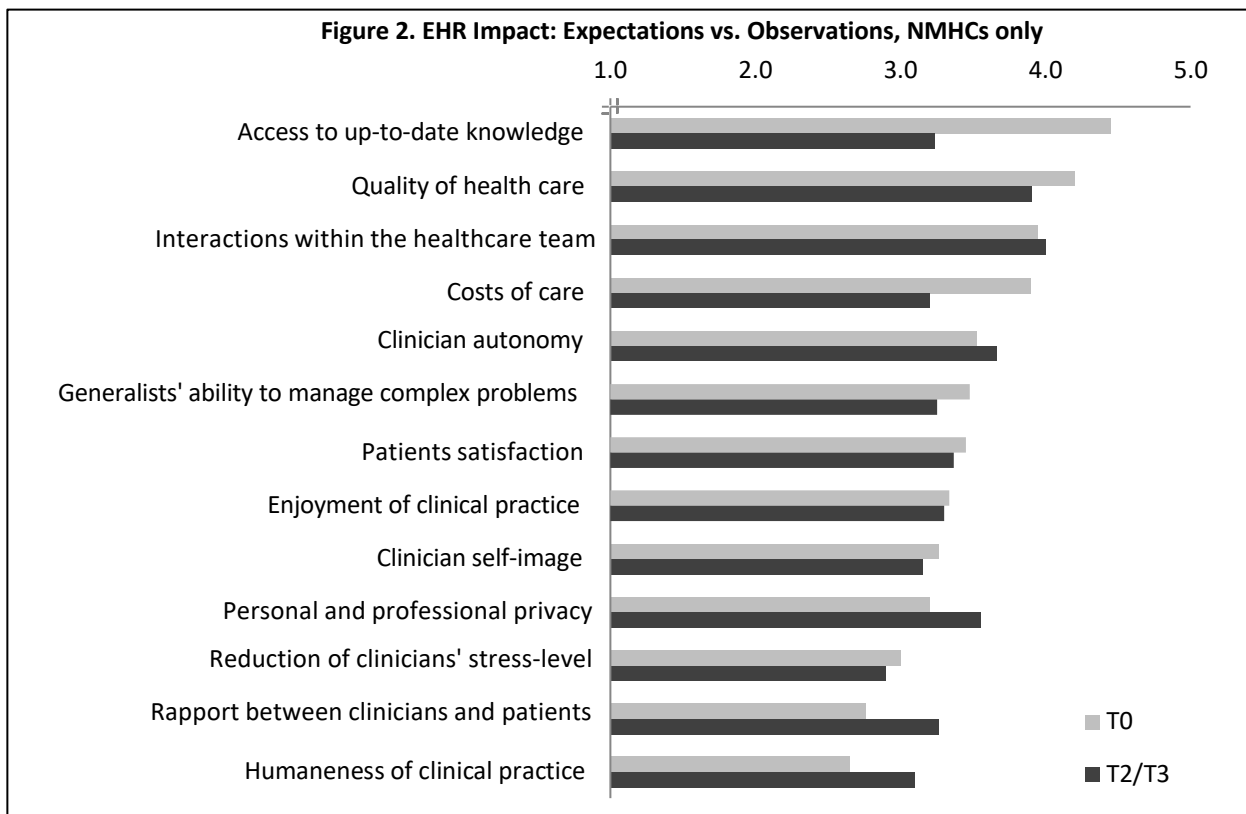
The research team conducted principal components factor analysis and reliability analysis, revealing three scales:

1. Overall satisfaction, 9 items, Chronbach’s alpha = 0.88
2. Effect of the EHR on clinical practice, 16 items, Cronbach’s Alpha=0.93
3. Satisfaction with the EHR use environment, 13 items, Cronbach’s Alpha=0.89

Each scale showed a similar pattern. During implementation (~ 3 months post go-live date) results at the NMHCs tended towards the negative side of neutral. The central tendency of post implementation results at the NMHCs became more positive at all NMHCs except NMHC2 (at which there were known implementation issues) – comparable to CHCs. A final time point over 2 years post implementation at NMHC2 showed improvement there as well. As described above, similar questions to the ‘Effect on clinical practice’ scale were included on the computer literacy survey conducted prior to go-live. Therefore we are able to present expectations compared to observations on this scale for NMHCs (Figure 1).



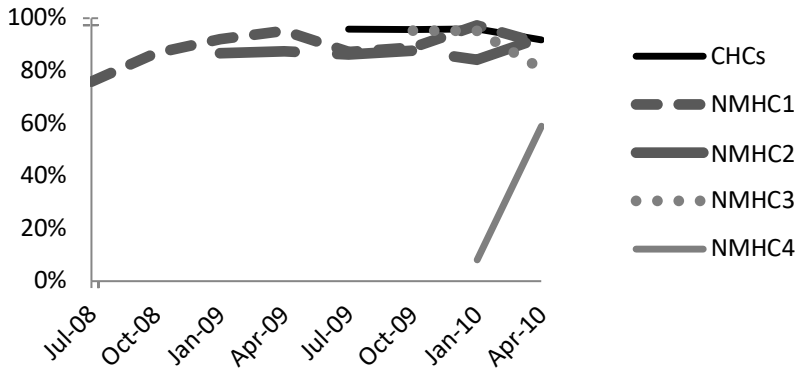
Comparing initial expectations and final observations (T2 for NMHC 1 and 3, and T3 for NMHC2) of the individual items revealed an overall moderation. Specifically in areas where expectations were high prior to go-live, there was some decline in the final rating. In areas where there was concern – specifically in the area of patient-provider relationships – fears appear to have been alleviated. These results are presented in Figure 2.





Use of EHR

**Figure 3. Percent of visits with a note in the EHR**



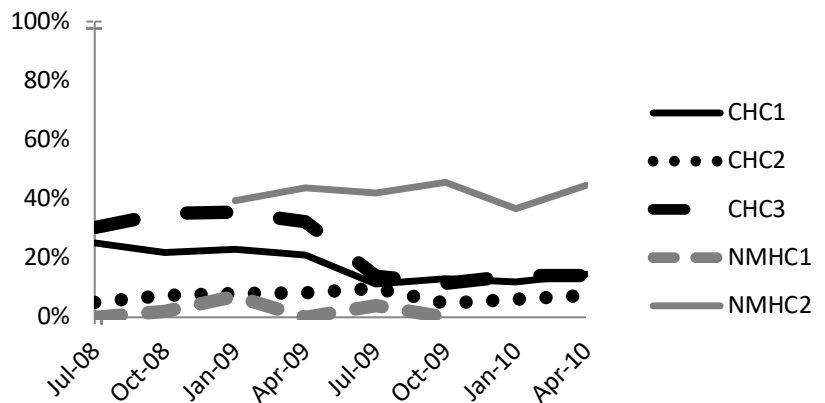
As listed above, the study used four indicators of EHR usage: 1) percent of visits with a clinical note in the EHR, 2-3) usage of disease management templates for appropriate visits (diabetes management and hypertension), 4) use of the evaluation and management coding advisor, and 5) self-reported use as measured in the clinician experience survey described above. The first four indicators were queried on a quarterly basis, although all had a 1-year look-back period. Measures two and three were meant to assess a higher level of EHR use, specifically: use of disease management templates that provided clinical decision support. Unfortunately, there was no way to directly query use of the disease management templates, other than by identification of the

presence of data elements that could only be entered using those templates. Here we summarize three measures: 1) percent of visits with a clinical note in the EHR, 2) utilization of the diabetes management template, and 3) self-reported use.

For those centers that reached stability (excluding NMHC4 for which there isn't sufficient data), the percent of visits with a note in the EHR varied from 39 to 97 percent by clinician (Figure 3).

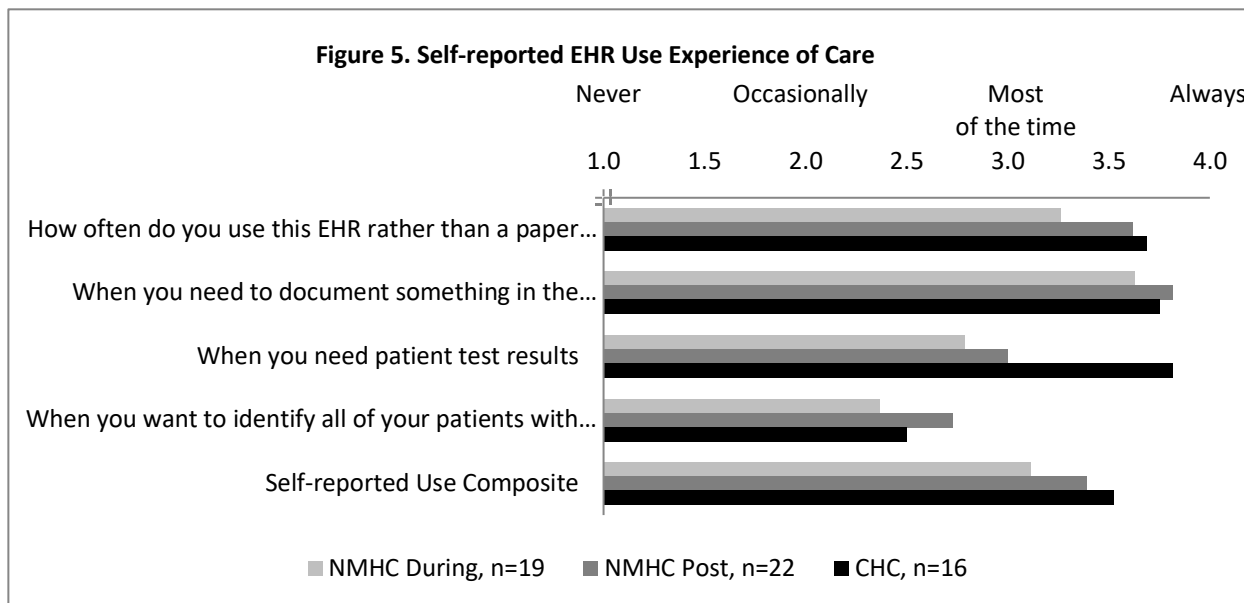
Usage of the diabetes template varied across centers. The two centers with the lowest use of the diabetes template (NMHC 1 and CHC 2) were centers with the youngest populations, and lowest rates of diabetes. CHC1 and CHC2 show a marked decline in usage between April and July of 2009. These data are presented in Figure 4. Usage of the cardiovascular template for hypertensive patients was uniformly low (data not presented). It was recognized by Alliance and Center leadership that this form was not convenient, and development of an alternative template was planned. Even so, usage of the template was higher at the NMHCs than at the CHCs.

**Figure 4. Percent of diabetes visits in which the diabetes template was use**



Finally, a measure of EHR use was included on the EHR End-user Survey (Figure 5). Respondents were asked to indicate how frequently they used the EHR rather than a paper record in general, and then for a series of specific tasks. A composite measure (the mean of the individual items) was calculated. Improvement is seen between during and post implementation time-points at the CHCs. In all but one area, NMHC post and CHC scores were comparable. The exception related to test results. This is easily explained by the extended time it took to implement the laboratory interfaces in two of the four NMHCs.

Clinician responses to the item, “How often do you use this EHR rather than a paper record?” is significantly (but modestly) correlated to measure of the percentage of clinician visits with a corresponding note in the EHR (correlation=0.466, sig=0.025).



Productivity

Productivity of primary care clinicians was measured quarterly using two different metrics: encounters per full-time equivalency (FTE), and relative value units (RVUs) per FTE. Encounters were defined as face-to-face visits between the clinician and patient. RVUs are a component of the Medicare physician fee schedule and are assigned to each procedure (CPT) code annually. RVUs summarize three aspects that comprise ‘value’ provided: !the complexity of decision making or skill level required to provide the service by the clinician (the ‘Work RVU’), administrative components (which vary by where the service was performed), and a risk or malpractice component.

Productivity analysis was not revealing in most centers. Productivity at NMHC1 was more influenced by seasonal variation in use than EHR implementation. NMHC3/4 both had fairly low productivity, and further reductions were unnecessary in order to transition to EHR. As expected all three CHCs showed stability of productivity during the time measured, although there were differences by center. NMHC2 did show a clear trend with productivity depressed for a full year and a quarter after EHR implementation – followed by a sustained rebound. All NMHCs had lower productivity than CHCs measured by both encounters/FTE and RVUs/FTE.

Quality

Three measures are presented here representing structure, process, and outcomes aspects of quality.

To measure structural aspects of quality at the center level, the study employed the Physician Practice Patient Safety Assessment tool (PPPSA) designed by the Medical Group Management Associates.<sup>5</sup> The tool begins with a demographics section that describes the overall practice type (13 items) and level of information technology adoption (15 items). The actual survey of practice safety is broken down into six sections: Medications (17 items), handoffs and transitions (11 items), surgery, anesthesia and sedation/invasive procedures (6 items, and we did not use this section as it was not relevant for any of the primary care sites), personnel qualifications/ competency (10 items), practice management/culture (22 items), and patient education communication (13 items). The research team identified a-priori a subset of items that were hypothesized to be facilitated by EHR. Items had a response of A = No activity; B = Considered but not implemented; C = Partially implemented in some areas; D = Fully implemented in some areas; E = Fully implemented in all areas; F = Not relevant/NA.

The tool was implemented in a group setting in which a skilled interviewer read each question and clinicians discussed each item and came to consensus around the best response. For the three NMHCs, the tool was administered at two different times: pre EHR implementation and post implementation (approximately 6 months after implementation). For the three FQHC sites, the tool was administered once, approximately 2 years post implementation since they had gone live before the study began.

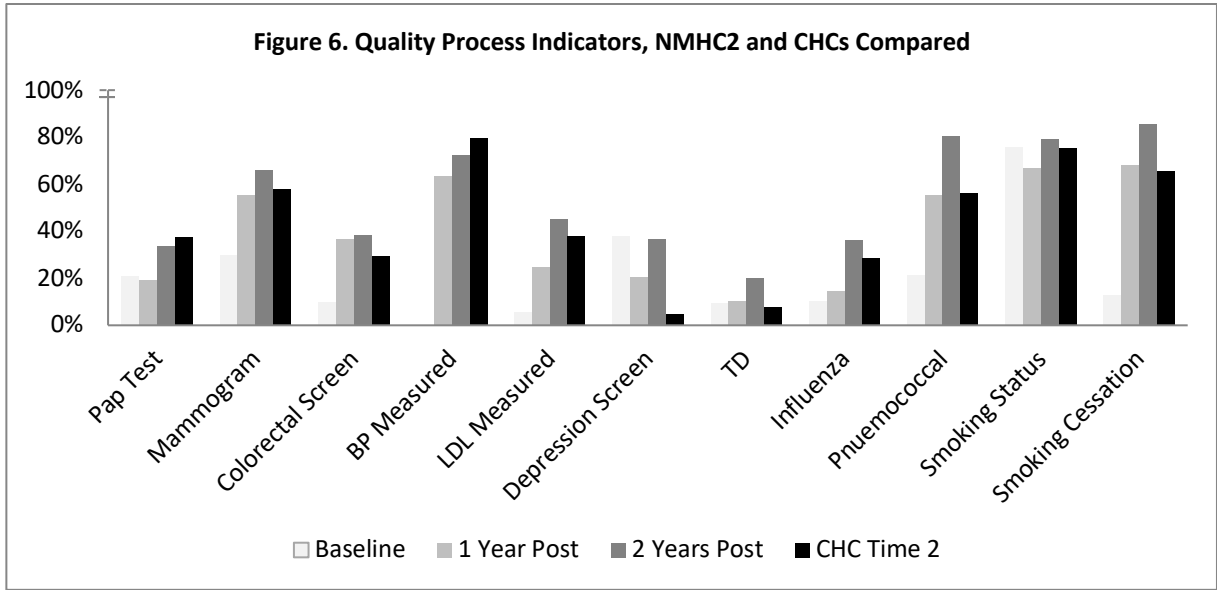
Table 4 presents data on all patient safety practices that the research team hypothesized that EHR could support. Symbols are used to classify items according to the following:

- + The practice was implemented fairly consistently across health centers post-EHR implementation
- ↑ The practice was reported to improve between pre-and post-EHR implementation at two or more NMHCs
- ~ The practice showed inconsistent implementation/improvement across centers

<b>Table 4. Patient Safety Practices with and without EHR</b>					
<b>Domain/Subdomain</b>		<b>Score after EHR (N=6)</b>			<b>NMHCs showing improvement (N=3)</b>
		<b>Min</b>	<b>Max</b>	<b>Mode(n)</b>	
↑ Shows improvement over baseline		+ Consistently high post EHR		~ Inconsistent	
<b>Medications</b>					
↑	<i>All prescriptions entered into an office-based eRx system</i>	2	5	5 (n=3)	2 centers improved
	<i>Manual or electronic system to document prescribed drug therapy</i>	3	5	5 (n=4)	2 centers improved
~	<i>Up-to-date written info about meds is available to pts who don't speak English</i>	1	5	3 (n=2) 1 (n=2)	2 centers improved
	<i>All meds dispensed to pts. are properly labeled</i>	3	5	4 (n=2) 3 (n=2)	1 center improved
	<i>Medication history documented on every patient</i>	2.5	4	4 (n=3)	1 center improved
	<i>Patients provided an up-to-date list of meds</i>	1	3	1 (n=3)	1 center improved
	<i>A list of high-alert drugs is established</i>	1	5	1 (n=4)	1 center improved
<b>Handoffs/Transactions</b>					
↑	<i>Practice has mechanism to determine "critical" tests</i>	4	5	5 (n=4)	3 centers improved
	<i>Practice has system to confirm discharge from hospital</i>	2	5	5 (n=3)	2 centers improved
	<i>Practice has process for communicating meds</i>	2	5	5 (n=3)	2 centers improved
↑	<i>Practice tracks when and to what imaging facility each patient is sent</i>	3	5	3 (n=3)	2 centers improved
	<i>Practice identified emergent situations for which pts. in office are at risk</i>	3	5	3 (n=3)	2 centers improved
+	<i>Practice gives pts. access to results and educates them on obtaining this info</i>	2	5	5 (n=4)	1 center improved
	<i>Practice has process to learn new info about patient outside of practice</i>	3	5	5 (n=4)	1 center improved
~	<i>Practice tracks patient orders</i>	1	5	3 (n=4)	1 center improved
	<i>Practice tracks patient referrals</i>	1	5	3 (n=4)	1 center improved
	<i>When pt is sent to another physician/practice for a consultation, the consultation is tracked</i>	2	5	3 (n=3)	1 center improved
	<i>When practice transfers responsibility for a pt's care, practice identifies new phys. accepts responsibility for the patient.</i>	1	5	3 (n=3)	0 centers improved

Table 4. Patient Safety Practices with and without EHR					
Domain/Subdomain		Score after EHR (N=6)			NMHCs showing improvement (N=3)
		Min	Max	Mode(n)	
↑ Shows improvement over baseline    + Consistently high post EHR    ~ Inconsistent					
	<i>Lab results communicated to pt. in timely manner</i>	2	5	5 (n=2)	1 center improved
<b>Practice Management/Culture</b>					
+	<i>Pt. Info is manually or electronically recorded in a way that's easily accessible to appropriate office personnel</i>	4	5	5 (n=5)	1 center improved
	<i>Patients instructed on proper use/maintenance of devices prescribed/dispensed to them by practice</i>	3	5	5 (n=4)	0 centers improved
	<i>Educational efforts are widespread among all clinicians and nonclinical personnel when errors or near-misses occur</i>	3	5	4 (n=2) 5 (n=2)	0 centers improved
~	<i>Practice encourages pts to share safety concerns</i>	1	5	4 (n=2) 5 (n=2)	1 center improved
	<i>Protocol to report potential threats allows for open data sharing w/in practice</i>	2	5	2 (n=2) 4 (n=2) 5 (n=2)	2 centers improved
	<i>Practice trains staff on patient communication</i>	1	5	3 (n=2)	2 centers improved
	<i>Practice uses information from published literature of errors and adverse to proactively make system changes within the practice</i>	1	4	3 (n=3)	1 center improved
	<i>Practice has protocols for following up on adverse events</i>	1	5	5 (n=2)	1 center improved
<b>Patient Education/Communication</b>					
↑	<i>Practice provides assistance to pts on how to obtain educational materials</i>	3	5	5 (n=4)	2 centers improved
+	<i>Info on pt's lifestyle, family, home environment is collected to develop a care plan</i>	3	5	5 (n=3)	1 center improved
	<i>Diagnostic/treatment plans communicated to patients and caregivers</i>	3	5	4 (n=2) 5 (n=2)	1 center improved

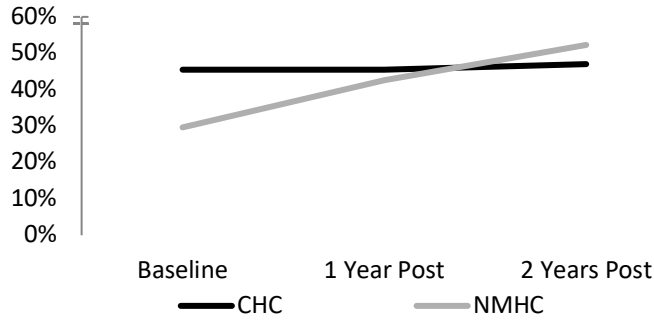
As described above, quality was also measured at the clinician level through use of a series of process quality metrics. Here we present NMHC2 at baseline, one year post, and two years post compared with aggregate CHC indicators (2+ years post). NMHC2 is chosen for presentation because of the comprehensive preload process and consequent high quality of baseline data. Improvement between baseline and post data is partially related to the ease with which information could be found in the paper record during the pre-load process, and partially a true reflection on quality of care. By one year post implementation, NMHC quality indicators were on par with CHC data. By two years post, NMHC quality indicators had surpassed CHC metrics in the following areas: measurement of LDLs, screening for depression, vaccinations, and smoking documentation and cessation.



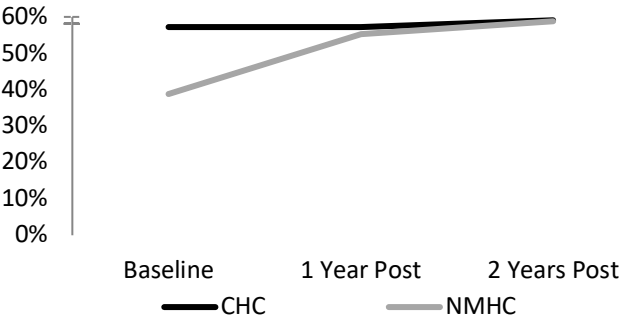
The project measured process and outcomes in the areas of diabetes and hypertension clinical variables. Figures 7 and 8 present a composite of diabetes measures. The composite created was based on the “Opportunity Model” employed by CMS.<sup>6</sup> The following 18 individual measures are included in the process composite score: patients with two HbA1cs in last year (at least three months apart); patients with HbA1c; self-management goal; taking ACE inhibitors or ARBs; on Statins; blood pressure measured; taking Aspirin or Antithrombotic; smoking status assessed; current smoker; smoking cessation offered; eye exam done; foot exam done; urine protein test; influenza vaccine; pneumococcal vaccine; dental exam; depression screening; exercise 3 time a week. The following 3 individual measures are included in the outcome composite score: HbA1C < 9, blood pressure <130/80, and LDL < 100.

On aggregate, the outcome score is positively correlated to the process score over the three time periods; NMHC scores increase both between baseline and one year post, and continue to increase between one and two years post implementation. As expected, the scores for CHC (our comparison group) show stability.

**Figure 7. Diabetes Process Composite Scores, NMHCs & CHCs Compared**

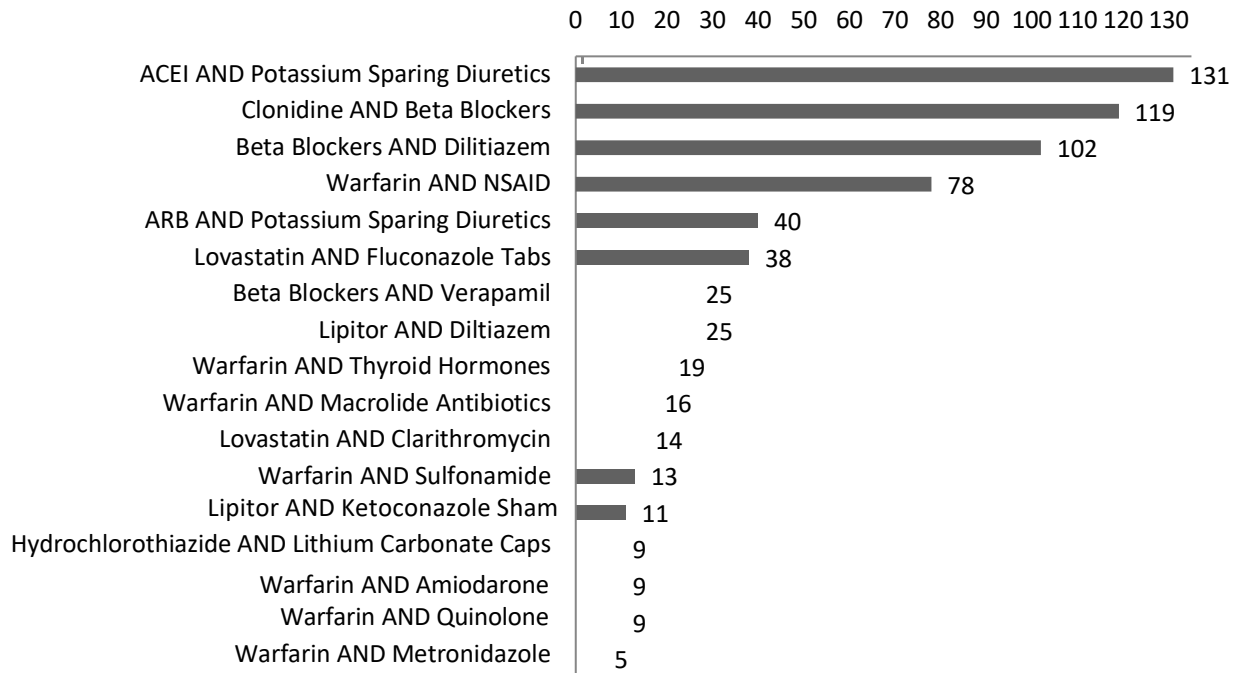


**Figure 8. Diabetes Outcome Composite Scores, NMHCs & CHCs Compared**



A final measure of quality for the study was in the area of medication safety. Medication safety was measured by the co-occurrence in the EMR of two drugs that had known serious interactions (referred to as drug-drug interaction pairs – or DDI pairs). In fact, such DDI pairs were a rare occurrence. Looking back to 2008 in all seven participating sites (with about 64,000 unduplicated patients), only 676 DDI pairs were identified. The distribution of these DDI pairs is shown in Figure 9.

**Figure 9. Distribution of # of DDI Pairs (total=679, pairs with <5 instances not presented)**



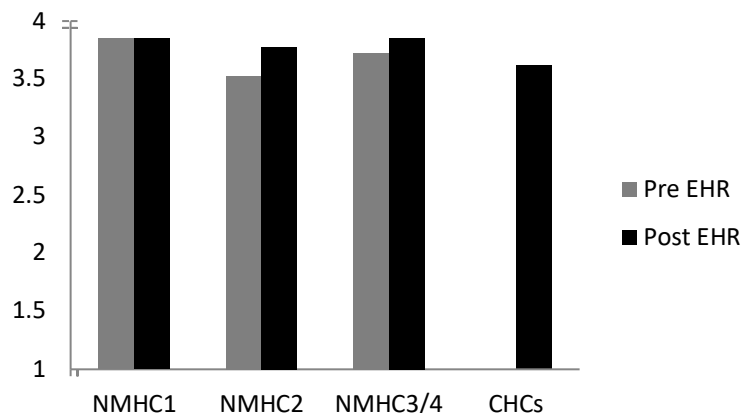
Further investigation revealed that 679 is a likely overstatement of the number of true DDIs because most of these DDI pairs were flagged as such because of a missing end date. Specifically:

- 594 of the 679 unique DDI pairs (88%) of DDI pairs had a missing end date on one or both drugs
- 228 or 33.6% had start dates within 1 month of each other

### Patient Satisfaction

Patient satisfaction was measured using a common tool pre and post EHR implementation in the NMHCs and once at the CHCs. The survey tool consisted of 23 questions and was made available in multiple languages for patients to complete during visits at participating centers. The development and validation of the tool by INC is reported elsewhere.<sup>7</sup> On a four point scale patient satisfaction was uniformly high both pre and post EHR implementation.

**Figure 10. Patient Satisfaction**



### Organizational Context

Understanding of context is crucial for interpreting results presented here. There are two sources of qualitative data on context: 1) extensive team notes, and 2) formal interviews conducted with key informants at each center. Information on the number and timing of interviews is contained in Table 5.

Timing	n	Setting
Pre-Implementation	15	NMHCs only
During Implementation	22	NMHCs Only
Post-Implementation	43	NMHCs n = 26 & CHCs n = 17
<b>TOTAL</b>	<b>80</b>	

Interviews were reviewed by all members of the research team which collectively developed and continued to adapt a coding scheme. Table 6 presents example quotations from themes identified in interviews.

Themes	Sample Comments
End User's pre-disposing personal factors (Age, Computer literacy, Previous EHR Experience (at a different health center). Had moderate level of responses.	"I think it is going to be hard probably for the first few months " "It will help us certainly with patient safety and ease of access to information"
Implementation (Finances, Optimization of use, Preload Process, Staffing, Time, Training (pre-implementation), Workflow. Had moderate level of responses.	"You know, I know I have to slow down for a while. Slowing down will put down my numbers but I've ramped up quite a bit this year so I think I can buffer that slow-down."
Organizational system (Change management, Communication (includes language barriers, IT/end user communication gap), Leadership). Had high level of responses.	"There's a lot of work here. It's exciting, but it's a lot of work.... We're going into organizational change theory and transitions, so the team is really gelling and we're looking at.... leadership styles to maximize impact, where we want the organization to be in 10 years"
Outcomes (Expected & Observed) ( <i>Clinician-level</i> outcomes/ stress, frustration/anger, performance anxiety, satisfaction/dissatisfaction), <i>Individual-level</i> outcomes for Other EHR Users (eg: nurses, admin. staff, MAs), <i>Organization-level</i> outcomes). Had high level of responses.	"... just knowing that the medications are correct, the doses are correct, I am able to read what they are, I am able to click on something and look at their problem list, medication list, being able to click on the flow sheet and being able to track that."
Support (Internal Support—staff and IT, Partner Support/Alliance). Had less than moderate number of responses.	"Well you know I am really impressed.... I have worked with Centricity in here and in Texas and the support that we have is amazing. I am very impressed with them. The only frustration is just the IT issues and they are getting better. In just a few weeks you know we were all being thrown off and that was a huge concern but you know they come up with a resolution quickly and a way to get us on board so you know, even when this happens 50 times a week, I don't hear from people that its not going to get better. Which is good."
Technology (EHR system/content, forms/templates, Hardware, Health Information Exchange, Network Performance/latency, connectivity). (Had fewest comments)	Comment at baseline: " Because right now as I see it, to be perfectly honest, if the system does have a two minute time-out, I can't use it in the room with the patient. I'll have to come out of the room and do everything and then come back in. Because if I spend so much time logging in to the system, you are disrupting the entire the flow of the patient interview." Or Comment during implementation in response to "How about the technology, how's that working? the wireless, the network?" That's not as problematic as I anticipated. because we've heard from other clinics that have had wireless that's slower than this one.

## Outcomes

The previous section presented principle findings in all areas of data collection: end user experience, patient satisfaction, productivity, and structure, process, and quality outcomes. In this section we re-visit the study goals and present data on the extent to which these concepts are inter-related.

### Clinician EHR Use and Quality

Diabetes Management Form usage at one year after implementation is significantly and positively correlated with the diabetes composite process scores both at one year and two years after implementation (Sig. =0.001, 0.000 and Pearson Correlation=0.564, 0.66, respectively). Diabetes Management Form Usage at year two is significantly and positively correlated with the diabetes composite process score at year two (Sig.=0.000, Pearson Correlation=0.567). But no significant correlations were found between DM Form usage and the DM composite outcome score.

We explored the correlation between the Note Use and the preventive measures by constructing a composite score for preventive measures using the “Opportunity Model”. But no significant correlation was found between these two.

### Productivity and Quarterly EHR Use

<b>Table 7. Correlation of Productivity &amp; Use</b>			
		E&M Form Usage	HTN Form Usage
<b>Q1 2009 RVU per FTE</b>	Pearson	0.477	0.753
	Sig.	0.084	0.007
<b>Q2 2009 RVU per FTE</b>	Pearson	0.541	0.635
	Sig.	0.056	0.036
<b>Q3 2009 RVU per FTE</b>	Pearson	0.501	0.643
	Sig.	0.081	0.033
<b>Q4 2009 RVU per FTE</b>	Pearson	0.155	0.395
	Sig.	0.539	0.182
<b>Q1 2010 RVU per FTE</b>	Pearson	0.505	0.567
	Sig.	0.027	0.055
<b>Q2 2010 RVU per FTE</b>	Pearson	0.449	0.482
	Sig.	0.054	0.059
<b>Q3 2010 RVU per FTE</b>	Pearson	0.497	0.646
	Sig.	0.059	0.023
<b>Q4 2010 RVU per FTE</b>	Pearson	0.412	0.577
	Sig.	0.113	0.039

Based on the NMHC’s data, the quarterly E&M usage and HTN Form Usage were found positively correlated to the quarterly RVU per FTE consistently, and most of the correlations were moderately significant. No significant correlations showed between the quarterly encounter per FTE and the quarterly EHR use measures, except in Quarter 1 of 2010, the encounter per FTE is significantly (Sig=0.039) correlated to Note Usage (Pearson=0.465).

### Local Context and Partnership Support

The importance of local context as documented in the qualitative data collection is illustrated by comparing the experiences of NMHC1 and NMHC2. These two NMHCs were highly motivated to adopt and utilize HIT/EHR to improve their operational efficiency and quality of clinical practice. However, due to resource constraints common in NMHCs, they encountered extreme difficulties on the journey toward EHR and in the aftermath of go-live as both practices struggled to use the technology meaningfully to transform the provision of their patient care services.

Challenges arising from their inadequate computer infrastructure and inability to get cooperation from external entities were particularly prominent. NMHC2, for example, experienced protracted difficulties in issues related to network connectivity and data interfaces, and clinician satisfaction scores reflect this trajectory. This observation also made it clear that having ancillary data integrated into EHR in a structured format, laboratory test results in particular, is pivotal to achieving user acceptance in a busy primary care practice. Unfortunately, both sites coped with an extended period in which laboratory data continued to be received in paper forms and faxes, despite best



effort. This deficiency was more significant for NMHC2 which had a population with significant chronic disease burden; whereas NMHC1 had a relatively young and healthy population and consequently lower need to monitor lab values.

The partnership provided continuous support to both of these sites after go-live including: (1) ongoing negotiation with the NMHCs' external partners (e.g., outpatient laboratories), (2) ongoing consultation and training on software customization and process optimization, and (3) ongoing conversations with the practices' leadership and parent organizations to gain resources to create facilitating conditions such as IT support. The partnership has also worked with the participating practice, from very early on, to create a collective capability at the NMHCs to enable them to actively participate in clinical, translational, and comparative effectiveness research.

## **Discussion**

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This ambitious project sought to demonstrate the relationship of EHR use to quality of care in seven centers serving safety net populations. A longitudinal model with a comparison group was employed – allowing the researchers to monitor change in outcomes through the implementation process at four NMHCs, and compare the post implementation results to CHCs that had been live on the same EHR, implemented in the same model, several years previously.

The partnership model of EHR implementation was promoted specifically to share resources and create an EHR-user community across safety-net settings. The team anticipated that there would be unique challenges of implementing an EHR in settings which are resource limited. NMHCs that do not attain FQHC status (like three of the four NMHCs in the current study), tend to not have a stable funding source to offset the uninsured and under-insured characteristics of the patient population, or to make sustained investments in IT. Despite the SWOT analysis and initial preparatory work on readiness for EHR in the NMHCs, issues arose that could not have been predicted such as certain environmental changes including the sudden downturn of the economy in California. Therefore, the partnership's continuous support after go-live played a pivotal role in helping centers reach the eventual implementation success. Such support included: (1) ongoing negotiation with the NMHC external partners (eg, outpatient laboratories); (2) ongoing consultation and training on software customization and process optimization and (3) ongoing conversations with the practices' leadership and parent organizations to gain resources to create facilitating conditions such as IT. Other challenges specifically related to resource limited settings included:

- Staffing issues included high staff turnover among full-time providers and administrators (financial and practice managers). Additionally, NMHCs faced challenges in providing intensive training and EHR practice opportunities to the part-time and volunteer staff they rely on.
- Technology limitations related primarily to the ability to access resources to upgrade and maintain the quality of connectivity required to use a remotely hosted EHR.
- One center did not have the political clout to require its main laboratory supplier (a community hospital) to build an interface until two years into the project.

In all these areas the ongoing support of the partnership was crucial:

- Partnership members provided weekly ongoing consultation over the phone to one center for over two years to assist with change management.
- Partnership members provided multiple on-site visits to each center over the three years of the project to negotiate with internal and external stakeholders to obtain needed IT resources and interfaces, and to provide refresher training and workflow consultation to center staff.

Overall quality improvement was shown to occur over time following EHR implementation as measured by structure, process and outcome metrics. Additionally, when compared to pre implementation, clinician experience and satisfaction rebounded after a year, although initially it dropped during implementation. Clinician expectations around EHR were generally moderated, but clinicians on balance expected and continued to believe in the positive effect of EHR on quality and safety.

Project attempts to measure the depth and quality of EHR use by individual clinicians – and thus measure the association with quality at the clinician level was hampered by several methodological challenges.

- The project tracked use and quality longitudinally by clinician. However, power was reduced by significant clinician turnover.
- Measuring clinician use itself proved challenging.

In regards to the latter point, one measure proved most useful, and was perhaps most valid: measuring whether a note was created for each visit. Attempts to measure more advanced usage were hampered by features of the system that were activated. Specifically, it was not possible to track over-rides of medication alerts. The research team utilized a CMS tool supplemented by pre-load experience to query pairs of medications known to have the potential for serious interaction effects. This inquiry uncovered rare drug to drug interactions (DDI). However, the exact frequency is unknown since it appears that many of the apparent DDI pairs were an artifact of situations in which prescription end-dates were not entered. Nor do we know how many times providers actually changed medication orders based on receipt of an alert.

Nor was it possible to track usage of chronic disease management templates with accuracy. The project employed proxy measures. In terms of diabetes management, the project was able to infer that if foot exam results were entered the diabetes management template was used because this was the only place to enter that result. (All other data points on the template could be entered into the system through alternative forms.) This raises two validity concerns: 1) clinicians not conducting/documenting foot exams may well have been using the form to document other things, 2) the diabetes management use metric is indistinguishable from the quality indicator relating to conducting a foot exam. In regards to hypertension management, the CDS template that was measured also served to measure cardiovascular disease management. This template did not support the clinical workflow of hypertension management, and was not a fair measure of clinician CDS use.

As described above the more general metric of creating a clinical note also contains the potential for error (in very specific but uncommon situations, a note in the EHR may not get linked to the visit record in the PM system – despite being an integrated product). Nevertheless, the validity of the note use measure was supported by a significant correlation to self-reported use of EHR rather than paper.

The project did measure use of the E&M advisor. This metric was significantly correlated with RVU/FTE. This finding is expected and supports the argument that EHR can ensure that providers document and code the complexity of office visits accurately. This feature is important for NMHCs – which notoriously under-code.

## **Conclusions and Implications**

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The project successfully demonstrated that careful EHR implementation in a model of sustained partnership and focused attention to quality of EHR use by clinicians had a positive impact on quality of care and experience of care by clinicians. However, the resources used to support this model were extensive and may not be practical or realistic without grant funding for most small primary care settings.

The experience and findings of this project are timely in the context of the current Medicare and Medicaid EHR Incentive and Regional Extension Center (REC) programs underway as the result of the 2009 HITECH Act.

These programs rely on clinician ability to demonstrate ‘Meaningful Use of EHR’. Metrics that have been established for “Stage 1” of meaningful use have a relatively low bar compared to what the current project was attempting to measure (and appropriately so, given the ambitious goal of having all providers convert from paper to electronic records despite immense variation in readiness). Specifically most Meaningful Use measures focus on structured data capture (which is required to drive rules engines or other patient specific CDS). The one Core Meaningful Use metric that specifically addresses CDS requires only attestation that one clinical decision support rule (other than medication alerts) is required to be ‘implemented’. The draft Stage 2 proposal in the area of CDS focuses on defining the attributes of CDS for the purposes of software certification, rather than on measurement of CDS at the clinician level. The key relevant lesson learned from this project affirms that in general use of EHR improved both process and outcome quality metrics over time. However, there are significant usability concerns in how CDS is implemented and this study found that measuring use of chronic disease templates that did not support clinician workflow was not a relevant metric. Moreover, to implement a true measure of CDS in a valid way requires specific tracking functionality within the EHR rather than making inferences based on data capture.

A second implication is relevant to the work of the RECs across the country. The very good news from the current study is that ongoing partnership support of centers facing significant implementation barriers can lead to successful outcomes. An extended and very challenging implementation experience in one NMHC created low morale and low productivity for a full year. But resolution of the underlying issues (related to connectivity and interfaces) combined with workflow consultation did lead to an eventual successful outcome. Clearly the resources required to achieve that outcome outstrip the much more limited resources of the REC program. Perhaps the consultation provided by the RECs can avert failures in implementations in which the setbacks are not so severe and prolonged.

Overall, the study confirmed the quality benefits that should be expected from implementing EHR in a carefully considered manner with ongoing support for clinicians and health centers using the system.

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## References

<sup>1</sup> Ansoff, HI. *Corporate Strategy*. New York City, NY, USA: McGraw-Hill; 1965.

<sup>2</sup> Deming WE. *Out of the Crisis*. Cambridge, MA, USA: MIT Press; 1982.

<sup>3</sup> Swanson B, Ramiller N. Innovating mindfully with information technology. *MIS Quart* 2004; 28(4):553–83.

<sup>4</sup> Cork RD, Detmer WM, Friedman CP. Development and initial validation of an instrument to measure physicians' use of, knowledge about, and attitudes toward computers. *J Am Med Inform Assoc* 1998; 5(2):164–76.

<sup>5</sup> Institute for Safe Medication Practices, Health Research and Educational Trust, and Medical Group Management

Association. *The Physician Practice Patient Safety Assessment*. 2006.

<sup>6</sup> <https://www.cms.gov/HospitalQualityInits/downloads/HospitalCompositeQualityScoreMethodologyOverview.pdf>

<sup>7</sup> Benkert R, Barkauskas V, Pohl JM, et al. Patient Satisfaction Outcomes in Nurse Managed Centers. *Outcome Manag Nurs Pract* 2002; 6(4), 174-181.

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## List of Publications and Products

### Publications

Zheng K, McGrath D, Hamilton A, et al. Assessing Organizational Readiness for Adopting Electronic Health Record System: A Case Study in Ambulatory Practices. *J Decis Syst* 2009;18(1):117-40.

Dennehy P, White M, Hamilton A, et al. A partnership model for implementing electronic health records in resource-limited primary care settings: Experiences from two nurse managed health centers. *J Am Med Inform Assoc* 2011; 18(6):820–6.

### Conference Presentations

Tanner C, Pohl JM, Breer L. A Partnership Model for Implementing Electronic Health Records among Safety-net Providers. PowerPoint presentation at Michigan's Public Health Technology Conference hosted by Michigan Assoc. for Local Public Health; 2008 Mar 18; East Lansing, MI.

Pohl JM, Tanner C, Zheng K, et al. EHR: Evaluate for Success. Poster Session at the AHRQ 2008 Annual Conference; 2008 Sep 7; Bethesda, MD.

Tanner C. Health Information Technology: Making the Case for Evaluation. Roundtable Discussion at the NNPHI Annual Conference; 2009 May 6; New Orleans, LA.

Zheng K, Pohl JM. A Partnership Model to Facilitate EHR Adoption and Improvement of Quality of Care in Safety Net Providers. Poster session at the MICHR Partners for Healthy Communities Symposium; 2009 May 11; Ann Arbor, Michigan.

Tanner C, Zheng K, Hamilton A, et al. A Partnership Model to Facilitate EHR Adoption and Improvement of Quality of Care in Safety Net Providers. Poster Session at AMIA 2009 Spring Congress; 2009 May 28; Orlando, FL.

Pohl JM. Nurse Managed Health Centers: Safety Net Settings and EHR. PowerPoint presentation at HIMSS Regional Technology Conference; 2009 Nov 2; Grand Rapids, MI.

Hamilton A, Dennehy P, Benkert M, et al. Using Health IT to Improve Community-Based Care. PowerPoint presentation at NNCC conference; 2009 Nov 6; Philadelphia, PA.

Tanner C, Zheng K, McGrath D, et al. Clinician Satisfaction and Use of EHR among Safety-Net Providers: Quantitative and Qualitative Findings. Poster session at AHRQ Annual Health IT Grantee and Contractor Meeting; 2010 Jun 2; Washington DC.

Tanner C, Pohl JM. A Partnership for Clinician EHR Use & Quality of Care. PowerPoint presentation at Alliance HIT Community Institute; 2010 Oct 7; Chicago, IL.

Hamilton A. Electronic Health Records in Community Health Systems. PowerPoint presentation at Purdue University School of Nursing; 2010 Oct 26; West Lafayette, IN.

Pohl JM, Hamilton A, Tanner C, et al. Clinician Satisfaction and Use of EHR among Primary Care Safety-Net Providers. Presentation at the American Academy of Nursing 37th Annual Meeting's Pre-Conference; 2010 Nov 11; Washington DC.

Pohl JM, Tanner C, Dennehy P, et al. Use of EHR and Clinician Satisfaction among Safety-Net Providers. PowerPoint presentation at NNCC 2011 Conference; 2011 Mar 16; San Antonio, TX.

Pohl JM. Nurse Managed Health Centers: Data Warehousing and EHR Among Safety-Net Providers. PowerPoint presentation at the University of Michigan School of Nursing Dean's Research Day; 2011 Mar 30; Ann Arbor, MI.

Tanner C. A Partnership for Clinician EHR Use and Quality of Care. PowerPoint presentation at Alliance Annual Research Meeting; 2011 Nov 10; Chicago, IL.