

***Grant Final Report***

---

**Grant ID: UC1 HS015420**

# **Electronic Records to Improve Care for Children**

**Inclusive dates: 09/30/04 - 09/29/07**

**Principal Investigator:**

Richard N. Shiffman, MD, MCIS

**Team members:**

Alia Bazy-Asaad

Nancy Banasiak

Paula Burns

Shlomi Codish

Laura Freebairn-Smith

Allen Hsiao

Peggy Simonette

Betsy Thornquist

Tina Tolomeo

**Performing Organization:**

Yale University School of Medicine

**Project Officer:**

Iris Mabry

**Submitted to:**

**The Agency for Healthcare Research and Quality (AHRQ)**

**U.S. Department of Health and Human Services**

**540 Gaither Road**

**Rockville, MD 20850**

**[www.ahrq.gov](http://www.ahrq.gov)**

# Abstract

**Purpose:** To implement a shared, community-wide electronic health record for health care providers in pediatric primary care, school health, specialty care, and emergency medicine., to demonstrate improvements in quality of care for children with asthma, to understand organizational barriers and factors that enhance IT acceptance and to provide administrative and technical elements of a community wide health network infrastructure that can be further extended to additional health partners.

**Scope:** Information technology can promote improved quality of care, but obstacles to the realization of an information infrastructure are formidable. Improved management of a prevalent chronic disease can serve as a focus for community-wide improvements in care.

**Methods and Results:** To evaluate progress, we (1) measured successes in creating and extending information linkages, (2) performed a retrospective record review to define baseline continuity of information error raters between the Pediatric Emergency Department and two community health centers, (3) implemented clinical decision support for chronic asthma management and combined it with audit and feedback to measure changes in processes of care, (4) conducted a qualitative investigation of personal hopes and concerns and organizational supports and barriers to HIT implementation, and (5) created an infrastructure for a community-wide health information exchange.

**Key Words:** electronic health record, clinical decision support, health information exchange, pediatric care

The authors of this report are responsible for its content. Statements in the report should not be construed as endorsement by the Agency for Healthcare Research and Quality or the U.S. Department of Health and Human Services of a particular drug, device, test, treatment, or other clinical service.

# Final Report

## Purpose

1. To implement a shared, community-wide electronic health record for health care providers in pediatric primary care, school health, specialty care, and emergency medicine.
2. To demonstrate improvements in quality of care for children with asthma.
3. To understand organizational barriers and factors that enhance IT acceptance
4. To provide administrative and technical elements of a community wide health network infrastructure that can be further extended to additional health partners.

## Scope

### IOM Quality Definition: Safety as a Vital Component of Quality

In its landmark report *Crossing the Quality Chasm*, the Institute of Medicine identified six characteristics associated with high-quality healthcare: safety, effectiveness, patient-centeredness, timeliness, efficiency, and equity. The report further recognized the critical importance of information technology in achieving all 6 of these aims: “(Information technology) must play a central role in the redesign of the health care system if a substantial improvement in health care quality is to be achieved during the coming decade.” A strong information infrastructure is required to support “the reengineering of care processes, manage the burgeoning clinical knowledge base, coordinate patient care across clinicians and settings over time, support multi-disciplinary team functioning, and facilitate performance and outcome measurements for improvement and accountability.”

Despite these potential benefits, obstacles to the creation of an information infrastructure are formidable. Electronic health records in the United States have not penetrated into the vast majority of practices. Barriers include the necessity for sizeable capital investments; essential behavioral adaptations on the part of patients, clinicians and organizations; concerns about privacy and confidentiality; and a need for standards for capture, storage, communication, processing, and presentation of health information.

## Asthma

Asthma is the most common chronic illness in childhood, accounting for 25% of school absences. The prevalence and rate of outpatient visits for asthma are rising, as is the mortality

rate. Children of color—especially those who live in urban communities—and those from lower socioeconomic strata have the highest prevalence of asthma. Asthma hospitalization and death rates have been highest in minority populations. Asthma care in the United States in 1998 accounted for an estimated \$12.7 billion.

Recently, researchers have come to understand that asthma is a chronic inflammatory disorder of the airways, and that persistent asthma is best controlled with daily anti-inflammatory therapy. However, clinicians have been slow to change their treatment of asthma in spite of advances in knowledge. Despite the fact that effective therapy exists, there is evidence of inconsistent and sub-optimal care of asthma in both children and adults. In a high risk population of previously hospitalized inner-city children with asthma, Legoretta found that only 72% of respondents with severe asthma had a steroid inhaler (only 54% used it daily) and only 26% had peak flow meters (of those only 16% used it daily). Likewise, Warman found that only 50% of families had a written action plan and only 39% with persisting symptoms were receiving daily anti-inflammatory agents. Underuse of anti-inflammatory agents is closely associated with lower educational attainment, suggesting special needs in addressing asthma care in low literacy populations.

The National Asthma Education and Prevention Program of the National Heart Lung and Blood Institute (NHLBI) published clinical practice guidelines for the management of asthma in adults and children. The guidelines were substantially updated in 1997 to reflect new knowledge from more than 6500 publications that had appeared since the original report was published in 1991 and underwent minor revisions again in 2002. The NHLBI guidelines address appropriate recognition of asthma, recommend a consistent categorization of severity, advise the use of anti-inflammatory medications for all persistent asthma, promote identification and mitigation of environmental triggers and allergens, recommend aggressive treatment for acute exacerbations, and recognize the importance of a partnership for care among parents, patients, providers, and schools. The guidelines propose a step-wise approach to asthma therapy, in which the choice of medications and their dosages are linked to asthma severity. The severity, in turn, is a function of the asthma classification and the current level of control.

## **Using Computers to Improve Quality of Care**

Continuity has been seen as a necessary attribute of high quality of care. Continuity is especially important for and valued by vulnerable populations. For inner city children with asthma and diabetes having a continuous relationship with a primary care provider is associated with substantially decreased risk of emergency department visits and hospitalization. Continuity of care is associated with high levels of patient satisfaction adherence to prescribed medications and diminished use of health services

On the other hand, discontinuity of care, as occurs necessarily when care is handed off from one clinician to another, poses a serious threat to patient safety “Gaps” are discontinuities in care that may result in loss of information” They may be caused by factors such as language barriers unavailability of clinical documentation on follow-up visits after emergency department visits and illegibility of records The American Academy of Pediatrics has recognized the critical importance of effective communication between emergency physicians and primary care providers In a policy statement, the Academy stated that primary care providers should make every effort to have background information on children with chronic diseases and special needs available to assist with appropriate emergency management. The emergency physician is

responsible for providing timely and legible feedback to the medical home about the treatment and disposition of the patient. A longitudinal computer-maintained record can help to alleviate gaps and consequent adverse events

Computers can also improve the effectiveness of care by providing prompts to remind clinicians about appropriate care and by helping in the development of treatment plans. Such *decision support* has long been considered to be an important component of the fully realized electronic health record; however, developers and vendors have not uniformly perfected mechanisms for delivering this valuable information in primary care. Effective integration of advice into clinical workflow has been found to be a critical success factor. In the proposed work, we will integrate a decision support system for asthma management into clinical workflow.

## **Area-wide Efforts to Share Clinical Information**

With a few exceptions, attempts to integrate clinical information sources to create an integrated area-wide record for patients have been disappointing. Once promising Community Health Information Networks (CHINs) and Integrated Delivery Networks (IDNs), have been hampered by data ownership and control issues, economic costs, privacy concerns, and acceptance by providers.

Successful models are few. The Veterans Administrations' VistA system has achieved considerable success, but it has been difficult to generalize its success to the private sector. Two U.S. communities have been recognized as leaders in information integration.

**Santa Barbara.** The Santa Barbara County Care Data Exchange is a public-private collaboration of providers for the secure exchange of patient-specific clinical information. The SBCCDE has demonstrated the organizational, technical, and legal feasibility of secure clinical data sharing. It focuses on institution-to-physician and institution-to-consumer information, thereby narrowing technical requirements to the sharing of reports, results, and personal health information. The system applies a browser-based interface with several layers of security, including confirmation of clinician identity through authentication and digital certificates, limited access to data through individual data holder rules, requirement for patient consent to view data, and routine auditing.

**Indianapolis.** The Indiana Network for Patient Care includes 11 hospitals (in 5 competing health systems), a large primary care network and a homeless care network. The Regenstrief Institute serves as a trusted broker of clinical information, with data from all participating organizations transferred to its database, where it is mapped to and stored in a single standard representation. All participants agree to a data sharing arrangement with access control, and business rules for data access. The upshot is that a clinician working at a participating site—with patient permission—can access a combined view of the patient's clinical encounters at all sites, e.g., the primary care physician at a community health center can access a patient's recent emergency room visit at the county hospital (including viewing radiographs and lab reports) and view summaries of previous hospitalizations at hospitals throughout the county.

## Unique Requirements for Pediatric Electronic Health Records

Pediatricians lag behind other primary care groups in adoption of electronic health records (Personal communication, David Bates, February, 2004). One reason cited has been that current systems have been developed to meet the needs of adult caregivers and fail to meet the needs of the pediatric environment. In response to this need, the American Academy of Pediatrics has developed a policy statement that outlines unique functionality requirements of the electronic pediatric health record, including support for flexible charting of growth parameters, prescription by weight, immunization practice support, and mechanisms for assignment of unique identifiers at birth. In this project, we will customize our electronic health records for use in pediatric care.

Site	Number of pediatric asthma patients
Primary care site: PCC	700
Primary care site: Hill Health	980
Primary care site: Fair Haven	840
Specialty clinic: Pediatric pulmonary clinic	1380
Specialty clinic: Pediatric immunology clinic	300
Acute care site: YNHH ED	3000 visits/year
Acute care site: YNHH Inpatient	391 admissions/year
New Haven Health Department	2700

Summary of pediatric asthma populations cared for by ER..ICCA partners in New Haven, CT

## Methods

**To Implement a Shared, Community-Wide Electronic Health Record for Health Care Providers in Pediatric Primary Care, School Health, Specialty Care, and Emergency Medicine.** At the outset of this Project, the Logician electronic health record system (GE Healthcare, Fairfield, CT—now called Centricity) had been implemented in the Yale New Haven Hospital (YNHH) Pediatric Primary Care Clinic and in its affiliated School-based Health Clinics. MDLink (Healthvision) offers a web-based portal to the YNHH data repository. With funding from AHRQ and matching funds:

- We implemented Logician in the Yale School of Medicine Pediatric Respiratory Medicine and Pediatric Allergy Clinics.
- We implemented a system in the YNHH Pediatric Emergency Department for recording discharge information in Logician.
- We asked residents on the YNHH inpatient units to record discharge information and action plans for asthma patients in Logician.

- We provided hardware and software to make MDLink available at the 2 New Haven federally qualified health centers, Fair Haven and Hill Community Health Centers.
- We developed and implemented a bidirectional interface for ambulatory health information stored in Logician to become available in MDLink (and vice versa).
- We developed and maintained a liaison with the New Haven Health Department and automated the process by which clinicians at the Yale Primary Care Center could order materials for asthma care for their patients from the city health department.

**To Demonstrate Improvements in Quality of Care for Children with Asthma.** The hand-off of patient care from emergency to primary care providers has been associated with critical safety problems, especially for children with chronic diseases. Continuity of care (COC) incorporates continuity of information (COI) as well as continuity of follow-up (COF). COI errors occur when relevant information is not transmitted effectively from one health care provider to another. Continuity of follow-up errors occur when a recommended visit or telephone contact do not take place as within the time frame prescribed.

We assessed the continuity of information and follow-up between a tertiary care pediatric Emergency Department (ED) and primary care providers for pediatric patients seeking acute asthma treatment.

In preparation for an electronic record implementation, we retrospectively reviewed paper records at two urban community health centers. Paper charts were reviewed for continuity of information and for evidence of follow-up within the guideline recommended five-day period after an asthma exacerbation.

- Medication continuity failure: a prescribed medicine is documented in the ED record but not recorded/legible in CHC record.
- Follow-up continuity failure: a recommended visit or phone contact does not occur within the interval prescribed in the ED note or 5 days.

We implemented a complex computer-based decision support system within our commercially available ambulatory electronic health record. The system accepted as input clinical data about patients being seen for asthma visits in our academic primary care center. It provided as output an assessment of asthma severity and level of control as well as recommendations based on the NHLBI EPR2 guidelines for asthma management in children. In addition, we provided clinicians with a quarterly summary of their practices vis-a-vis recording asthma on the patient problem list, categorizing asthma severity, and prescribing appropriate pharmacologic interventions for children with persistent asthma.

A number of challenges presented themselves: Case finding of asthmatics was more difficult than expected, even with EHR. Text searches returned “no asthma,” “FH of asthma”; albuterol therapy was used for patients with bronchiolitis and pneumonia; accurate identification of patients’ asthma classification was complicated by multiple abbreviations and misspellings; influencing residents to use decision support software was complicated by their lack of comfort in charting in the exam room; the number of asthmatic patients seen by each resident in a 3-month period for health maintenance or asthma followup is small.

**To Understand Organizational Barriers and Factors that Enhance IT Acceptance.** To investigate perceptions and attitudes about factors that enhanced or interfered with acceptance of EHRs in the Emergency Department, pediatric Primary Care Center, and pediatric specialty clinics at Yale New Haven Hospital, we used a combination of quantitative and qualitative methods, based on grounded theory. These included surveys, semi-structured interviews, direct ethnographic observations and artifact analysis performed before, during, and after implementation.

**To Provide Administrative and Technical Elements of a Community Wide Health Network Infrastructure That Can Be Further Extended to Additional Health Partners.** The ERICCA Project brought together multiple community healthcare stakeholders and received considerable attention. During the time interval that was supported by this grant, eHealth Connecticut was organized and recognized as the statewide Regional Health Information Organization. The PI (Richard Shiffman) of the ERICCA Project contributed to the organization of eHealth Connecticut and continues to serve on its Board of Directors. This representation has helped to assure that ERICCA activities were highlighted at the state level.

During the summer of 2007, representatives from Yale New Haven Hospital, Fair Haven Community Health Center, Hill Health Center, the Hospital of St. Raphael, and Griffin Hospital signed a Memorandum of Understanding (MOU).

## Results

The findings from these studies will be reported in the general medical and informatics literature as noted in Section 7 below. To avoid issues of duplicate publication, we describe our results in broad terms and refer interested readers to the literature.

**To Implement a Shared, Community-Wide Electronic Health Record for Health Care Providers in Pediatric Primary Care, School Health, Specialty Care, and Emergency Medicine.** As noted above, we successfully met the implementation goals.

**To Demonstrate Improvements in Quality of Care for Children with Asthma.** Following review of records from the Emergency Department and the 2 community health centers, we conclude that continuity of care is often not achieved: COI and COF failures are common. Sharing information electronically between EDs and primary care providers has the potential to diminish these errors and to improve patient safety.

Over 5 quarters, residents practicing in our pediatric Primary Care Center and advanced practice RNs practicing in the PCC and school-based health clinics improved the frequency of recording asthma on the problem list, categorizing asthma severity, and adherence to guidelines for appropriate pharmacologic interventions.

A manuscript that describes these results in detail is in preparation.

**To Understand Organizational Barriers and Factors that Enhance IT Acceptance.** The qualitative and quantitative data clustered into four categories – personal hopes and concerns and

organizational supports and barriers. Hopes declined from pre- to post-implementation. A manuscript describing these findings is in preparation.

Additional findings included:

- Pre-existing organizational dysfunction is amplified during the implementation process. Administrative units in which there was pre-existing lack of teamwork find that the condition is exacerbated by the implementation of EHRs.
- An individual's level of comfort with the use of computers had mild to moderate impact on willingness to use EHRs. However, carefully designed training can overcome resistance to EHRs due to computer "discomfort."
- The physical location of the computers and the amount of physical space allocated for computer use have substantial effects on utilization.
- Having a "consistent champion" who is on-site, computer knowledgeable, and of relatively high status in the health care hierarchy greatly enhances the odds of successful implementation.

**To Provide Administrative and Technical Elements of a Community Wide Health Network Infrastructure That Can Be Further Extended to Additional Health Partners.** In their Memorandum of Understanding, the community stakeholders recognized:

- Thousands of greater New Haven residents receive healthcare services from multiple provider organizations across the continuum of care, from community physicians, community health centers, primary care clinics, specialty clinics, acute care medical centers, and a multitude of other care delivery types and locations, and often this care is not as well coordinated as it could be, leading to patient confusion, duplicated services, and risks to patient safety.
- We serve a large number of patients with low levels of income and healthcare literacy. These individuals have difficulty understanding and conveying information about their healthcare problems and services, increasing the risks of duplicated care and care that can cause harm if it conflicts with treatment provided elsewhere. As a result, the total cost of care and provider liability are increased, and patient care may be compromised.
- Healthcare quality, patient safety, and utilization efficiency can be dramatically increased in the greater New Haven community with the collection and exchange of patient specific electronic healthcare data from all points along the continuum of care. This information should include patient problems, medication history, laboratory and diagnostic imaging test results, allergies, encounter history and services provided.
- With additional information gathered from this Health Information Exchange (HIE), providers will be better able to provide optimal patient care, to increase care access and

coordination, and to implement community based programs that meet the needs of our population.

- HIE will be possible only if participating providers and other stakeholders adopt data interchange standards.
- HIE will be adopted only if consumers and organizations understand how it will work and how privacy and security will be ensured.

They agreed to take the following actions:

- Collaborate to achieve the following results.
- Increase access to care for those who are underserved.
- Increase continuity of care for those who receive healthcare services from multiple providers in multiple organizations.
- Reduce the number of disease and health problems in the community by identifying population trends and developing proactive disease management and health management programs that can be coordinated across care delivery organizations.
- Enhance the quality of care and patient safety by making relevant clinical and demographic data available at the point of care, from multiple care settings.
- Increase efficiency by reducing the number of unnecessary tests, implementing effective disease management, and automating the flow of electronic health data from source systems through a trusted HIE.
- Adopt HIE standards and privacy/security policies consistent with national standards and standards being adopted by others throughout Connecticut. Collaborate with eHealthConnecticut to identify standards.
- Determine the best way to implement the HIE, with options ranging from establishing technical infrastructure in New Haven to leveraging a statewide infrastructure such as that planned by eHealthConnecticut.
- Start work on these initial tasks.
- Develop the procedures for membership and governance model.
- Identify additional stakeholders to participate, such as community providers, employers and payers, and determine when they should be engaged to join.
- Define measurable goals.

- Develop a communications plan to educate residents, providers, employers, payers, and other stakeholders about the functions and benefits of HIE.
- Secure funding and resources from sources willing to help the collaborators in this agreement achieve the goals of this Memorandum of Agreement.

## **Conclusions, Significance, Implications**

This project is significant and innovative for a number of reasons.

We confronted a serious chronic health problem—asthma—in a particularly vulnerable population—inner city children (an AHRQ-defined priority population).

The project directly addressed critical quality and safety issues in the care of children with asthma. We identified an unexpectedly high level of continuity of information errors and continuity of followup errors in our community. We have taken important steps toward remedying those failures.

We implemented an electronic infrastructure among children’s health care providers in our community that can be scaled to other populations.

We involved competing hospitals, an academic department of pediatrics, neighborhood health centers, school health and public health in a community partnership. Such community partnerships are rare, yet they will be critical components of the National Health Information Infrastructure—currently envisioned as a comprehensive network of interoperable systems of clinical, public health, and personal health information.

We applied an innovative framework to understand issues that arise organizations when health information technology is implemented. We anticipate that our findings will contribute to a burgeoning literature on overcoming implementation barriers.

The planned implementations afford enhanced quality of care. Lessons learned can be generalized because Centricity and MDLink are vendor-supplied products that can be purchased and installed by others.

We created a team of stakeholders that effectively managed the project and achieved its stated goals. Ongoing activities with the New Haven Health Information Exchange and eHealth Connecticut should sustain and enhance our achievements.

# List of Publications and Products

## Website

We created a website at [gem.med.yale.edu/ericca](http://gem.med.yale.edu/ericca) that has been used for internal communication and will be used to direct interested readers to our products.

## Presentations

The following presentations disseminated information about our successes in creating an HIE, improving quality thru decision support, and lessons learned about successful implementation.

Electronic Records to Improve Care for Children With Asthma. Connecting Kids through Child Health Information Systems Meeting (sponsored by the National Children's Health . Orlando, FL March 15, 2006.

ERICCA: A Health Information Exchange for New Haven. eHealth Connecticut Inaugural Summit. Farmington, CT, March 23, 2006

Sharing Information Across Organizations in New Haven. New Haven Health Information Exchange Inaugural Meeting. April 25, 2006

A Tale of Two Cultures: Guideline Authors and Guideline Implementers. AHRQ Expert Panel on Electronic Guidelines, Washington, DC. December 12, 2006.

Toward Improved Guideline Quality and Transparency. American Academy of Otolaryngology-Head and Neck

Surgeons Committee on Sinusitis. Rosemont, IL; December 3, 2006.

Electronic Health Records in Pediatric Care. New York University School of Medicine Pediatric Grand Rounds, New York, NY. April 24, 2007.

A Health Information Exchange for New Haven. eHealth Connecticut Health Information Technology Jamboree. Hartford, CT. June 28, 2007.

Electronic Records To Improve Care for Children With Asthma. AHRQ Annual Meeting. Bethesda, MD. September 26, 2007.

Healthcare Quality's New Friend: Information Technology (Meet-the-Expert Session). AAP National Conference and Exhibition. San Francisco, CA. September 27, 2007.

## Manuscripts in Preparation

Codish S, Shiffman RN. Improving Asthma Care with Complex, Guideline-based Clinical Decision Support.

Hsiao A, Shiffman RN. Dropping the Baton During the Handoff from ED to Primary Care: Pediatric Asthma Continuity Errors

Freebairn-Smith L, Shiffman RN. Changing Expectations – Fantasy Meets Reality in the Implementation of Health Information Technology

Tolomeo C, Shiffman RN, Bazy-Asaad, A. Electronic Medical Records in a Sub-Specialty Practice: One Asthma Center's Experience.