Exploiting Health Information Technology to Improve Health

The MetroHealth System

2015 Davies Award Enterprise Application

David Kaelber, MD, PhD, MPH

Chief Medical Informatics Officer and Vice President of Health Informatics

Don Reichert

Chief Information Officer and Vice President of Information Services
Davies Enterprise Award Application

Date: August 14, 2015

Organization Address: 2500 MetroHealth Drive, Cleveland Ohio 44109

Submitted Name: David Kaelber, MD, PhD, MPH / Don Reichert

Submitter Title: Chief Medical Informatics Officer / Chief Information Officer

Submitter email: dkaelber@metrohealth.org / dreichert@metrohealth.org
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The MetroHealth System Overview

The MetroHealth System was founded in 1836 and is the tertiary care, public/essential health system in Northeast Ohio, academically affiliated with Case Western Reserve University’s School of Medicine in Cleveland Ohio.

Key operational statistics for 2014 include:

Patient Care Statistics
- Outpatient Visits: 1,026,667
- Emergency Department Visits: 106,153
- Inpatient Stays: 27,933
- Surgical Cases: 18,648
- Babies Delivered: 2,920

Provider Statistics
- Physicians: 507
- Resident Physicians In Training: 374
- Nurses: 1,222

Financial Statistics (2014)
- Total Operating Budget: $784.0 Million
- Total Capital Budget: $32.7 Million
- IS Operating Budget: $25.1 Million
- IS Capital Budget: $4.8 Million
- % IS Operating Budget to Total: 3.2%
- % IS Capital Budget to Total: 15.0%
- Uncompensated Care: $126 Million

Payer Mix
- Commercial Insurance: 26%
- Medicare: 28%
- Medicaid: 38%
- Self-Pay/Other: 18%
The MetroHealth System HIT Systems
Overview

The MetroHealth System (MHS) was the first public/essential health system to ever install the Epic electronic health record (EHR), going live in our ambulatory clinics starting in 1999. In 2014, the MHS became the first public/essential health system ever with the Epic EHR to achieve Stage 7 in the HIMSS electronic medical record adoption model (EMRAM) in both its inpatient hospital and all of its ambulatory clinics.

Key HIT system implementation milestones include:

- **1999** – Ambulatory EHR
  - Clinical documentation and ordering (EpicCare)
  - Scheduling (Cadence)
  - Registration (Prelude)
  - Billing (Resolute)
  - Case Management (Tapestry)
- **2004** – EHR in Emergency Department (ASAP)
- **2009** – Inpatient EHR
  - Clinical documentation and ordering and medical administration record
  - Inpatient pharmacy (Willow)
  - Oncology (Beacon)
- **2011** – Health Information Exchange (Care Everywhere)
  - e-Rx (SureScripts)
  - Personal health record (MyChart)
- **2012** – Epic Enterprise Contract
  - Meaningful Use Stage 1
- **2013** – Bar Code Medication Administration
- **2014** – Admission, Discharge and Transfer
  - Bed Tracking (Bed Time)
  - OR (OpTime)
  - Inpatient professional and technical billing (Resolute)
  - Meaningful Use Stage 2
  - HIMSS EMRAM Stage 7 Ambulatory and Hospital
- **2015** – Ophthalmology specialty module (Kaleidoscope)
  - 1st Epic customer to sign Epic’s Research Data Governance “Rules of the Road”
Larger Electronic Health Record Community Contributions

Notable External Recognition for MHS HIT-enabled efforts:

- **Underdiagnosis of Hypertension in Children and Adolescents** (2007 – American Health Association top 10 cardiac research advances)

- **Electronic Medical Record Assisted Design of a Cluster-Randomized Trial to Improve Diabetes Care** (*Cluster randomized trial for informatics* (2008 – Cluster randomized for informatics research recognized by the American Medical Informatics Association (AMIA) as one of the top 10 informatics advances)

- Electronic disease reporting for public health (2009 – 2nd site to implement Electronic Support for Public Health (ESP) software)

- **Electronic Health Records and Quality of Diabetes Care** (2011 – one of the AMIA top 10 informatics advances)

- **Advanced Clinical Decision Support for Vaccine Adverse Event Detection and Reporting** (2011 – EHR immunization adverse event reporting to the Centers for Disease Control and Prevention (CDC); first known site in the US to automate detection and reporting of vaccine adverse events to the CDC)

- Use of the EHR to combat Acinetobacter (2011 – Association of Medical Directors of Information Services (AMDIS) award)

- Increase of Up-To-Date Pediatric Immunizations (2012 – designated by the Epic Corporation as a “Clinical Program” and recognized by The Joint Commission as a “best practice” immunization tracking and ordering system)


MHS staff presented over 30 presentations at Epic User and Expert Group vendor EHR conferences, including several “classics” lectures (voted on by other Epic customers). Dr. Peter Greco was also one of the first people to win the Epic Corporation’s PACademy award (nominated and selected by fellow Epic customer physicians as making extraordinary contributions to the Epic community).

A bibliography of the more than 75 MHS presented or published EHR related scientific abstracts and manuscripts is included in Appendix A. This work exemplifies:

1. How MHS continualy strives to evaluate, generalize and disseminate EHR (and HIT) related activities for others to benefit from
2. How MHS uses EHRs to perform novel non-EHR specific research
Acknowledgments/Dedication

This Davies award enterprise application would not have been possible without the efforts of thousands of people throughout the MHS and our partners over the last two decades. These individuals (past and present) share a vision for health information technology. They have worked and continue to work together to enable the MHS to use health information technology to help achieve the MHS’s vision to “be the most admired public health system in the nation, renowned for our innovation, outcomes, service and financial strength.” We dedicate this Davies application to all the individuals who have helped make the accomplishments documented in the application possible and to our patients and community whose health we are continuously working to improve.
Core Case Study: Clinical Value

Executive Summary
The MetroHealth System (MHS), a safety-net/essential healthcare system in Northeast Ohio affiliated with Case Western Reserve University’s School of Medicine, started to implement the Epic electronic health record (EHR) throughout MHS ambulatory clinics in 1999. By 2009, the MHS had fully deployed Epic enterprise-wide: throughout all ambulatory clinics, inpatient areas, and the emergency department. Over the last five years the MHS has focused on enhancing the use of the existing EHR foundation to do things not possible without a fully deployed, enterprise EHR and to meet ongoing MHS needs.

Local Problems
The MHS views the EHR as a critical component of administrative, clinical, operational and quality activities. As such, numerous areas of the healthcare system are continually asking if/how the EHR can help issues/opportunities their areas are interested in. Additionally, information services and informatics staff are always looking for opportunities to leverage existing and new EHR functionality in ways to improve the MHS.

The health information technology (HIT) value examples described in this section represent a broad sampling for the local problems the EHR has been used to address within the MHS. The HIT value examples include:

- Health information exchange
- Heparin (high risk medication)
- Code status reconciliation
- Vaccine adverse event reporting
- Outpatient depression screening
- Automated patient clinical messaging
- Internal referral completion
- Common high risk/high cost hospital acquired infections
- Core measures
- Blood pressure diagnosis research and improvement
Health IT Value Example: Health Information Exchange

Brief Overview

The Health Information Exchange value case primarily demonstrates electronic health information exchange/data value in terms of the HIMSS STEPS Model, but the MHS experience also shows value in patient satisfaction and operational and efficiencies savings. For over a decade, the MHS has recognized the potential to significantly improve healthcare value (quality of care / cost of care) through electronic health information exchange (HIE). To achieve the enhanced value with HIE, HIE must also be efficient and integrated into the clinical workflow to the greatest degree possible and ideally also improve patient satisfaction. An overview of the MHS’s HIE strategy appears in Figure 1.

Figure 1 – MHS electronic health information exchange overview

Care Everywhere Initial Efforts and Evidence of Value

Within our overall HIE efforts, over the last five years MHS has specifically focused on implementing and evaluating real-time, two-way clinical HIE through Epic’s Care Everywhere platform. Although the MHS was involved in a number of HIE efforts prior to Care Everywhere, none involved real-time, two-way clinical information exchange. The MHS first implemented Care Everywhere in the fall of 2010, starting in our Emergency Department as a pilot and then expanding throughout our healthcare system in the beginning of 2011. At the time, we deployed Care Everywhere in conjunction with the Cleveland Clinic Foundation (another Epic customer in Northeast Ohio). Initially, written consent was required to initiate the search process to locate information in other Epicsystems.
Through the first 14 months of Care Everywhere’s implementation, the MHS carefully monitored Care Everywhere’s use and assessed its value through a combination of objective data and user surveys. Figure 2 shows the use of Care Everywhere in its first 14 months by site of care. Highlights of these findings show that HIE was used on ~6% of patients. Almost 80% of providers who used Care Everywhere indicated that it caused them not to order a test (lab or imaging) that they were otherwise planning to order and approximately 17% of providers who used Care Everywhere stated that it caused them not to admit a patient they were otherwise planning to admit (Figure 3). Table 1 shows patient characteristics associated with an increased odds ratio of having electronic health information occur. The complete findings of our initial Care Everywhere analysis were published in 2013 in a special health information technology issue of the American Journal of Managed Care – Use and Perceived Value of Health Information Exchange – One Public Healthcare System’s Experience.

Figure 2 – MHS rate of Care Everywhere (CE) patients versus non-CE patients/1,000 patients by care setting
Figure 3 – Self-reported impact of Care Everywhere on providers, by type of provider, who had used Care Everywhere at least one-month post-go-live

Table 1 – Objective patient characteristics comparing those patients who had at least one Care Everywhere encounter and those having no Care Everywhere encounters. Odds ratios of statistically significant characteristics are BOLDED – increased age, female gender, African American and Others/Unknown race/ethnicity, commercial, Medicare and Medicaid insurance and increasing numbers of co-morbidities
Care Everywhere Continued Efforts and Evidence of Value

Since our initial implementation and evaluation of Care Everywhere, the MHS has continued to enhance its HIE capabilities and track its progress knowing that the higher the volume of HIE that occurs and the more information the MHS can exchange in each HIE, the better care the MHS can provide to its patients.

Highlights of recent efforts include:

1. February 2014 – became one of the first Epic customers to begin data exchange with Social Security Administration (SSA) through the Sequoia Project (formerly known as the Healthway). For every data exchange that the SSA pulls from the MHS, the MHS receives ~$10 net payment.
2. June 2014 – became one of the first Epic customers to begin data exchange with the Veterans Administration through the Sequoia Project (formerly known as the Healthway).
3. Summer 2014 – led regional effort to implement nightly and ED/inpatient ADT “auto-querying” for all Care Everywhere sites within a 150 mile radius of healthcare system and patient zip codes.
5. May 2015 – became one of the first Epic customers to implement non-ED walk-in/same-day ADT “auto-querying” for all Care Everywhere sites within a 150 mile radius of healthcare system and patient zip code.
6. June 2015 – became one of the first Epic customers to implement fully integrated pediatric growth chart integration of external data (Figure 4).

Figure 4 – Electronic health record screen shot of patient with fully integrated external growth chart data (light blue circles) combined with native electronic health record data (dark blue circles)
Figure 5 summarizes our overall Care Everywhere volumes over the last year. Figure 6 shows our continued monitoring of Care Everywhere metrics at the end of the first half of 2015.

Figure 5 – Patient Records Sent and Received from MetroHealth through Care Everywhere from April 2014-March 2015, compared to Epic Community Average Peer Institutions. 1 – HIE Go-Live with Social Security Administration, 2 – HIE Go-Live with Veterans Administration, 3 – Encouraged Regional CMIOs at other institutions to drop separate written consent requirements for HIE, 4 – Encouraged Regional CMIOs at other institutions to adopt auto-querying overnight batch and ED/inpatient admission querying process, 5 – Began auto-querying for same-day/walk-in appointments, 6 – Dropped separate written consent requirements for HIE, 7 – Began auto-querying overnight batch and ED/inpatient admission

Figure 6 – Ongoing Care Everywhere metrics shown at the end of first half of 2015.

Implementation and Value Summary
Overall, our decade long strategic focus on HIE, focusing specifically on Care Everywhere over the past five years, has led to many fold increases in the volume of electronic documents exchanged. This increase in volume of electronic documents exchanged has led to increased provider efficiency, enhanced patient experience and decreased healthcare costs because of fewer tests being ordered and fewer patients being admitted. Quantifying the decrease in
healthcare costs because of fewer tests and fewer admissions is complicated, and in the current healthcare system, these decreased costs manifest themselves as decreased MHS charges and therefore decreased revenue for MHS because the real cost savings is to the payer. For uninsured patients within the MHS, MHS acts as their payer and so cost savings for this group results in more direct savings to MHS. Estimates of the ROI of HIE for the MHS (based on SSA payments and decreased testing and admissions among the uninsured patients calculated as 2% cost elimination among the 6% of our uncompensated care (uninsured) patients that had HIE since HIE was available) appear in Table 5 of the Core Case Study: Financial Value.

Health IT Value Example: Heparin (high risk medication)

Brief Overview
The Heparin value case exemplifies a treatment/clinical case from the HIMSS STEPS model. After a sentinel event at the MHS involving heparin led to a patient safety network (PSN) report, a root cause analysis identified several EHR factors as potentially causing patient safety issues related to heparin, including:

- Multiple (eight) versions of heparin order sets and protocols
- No discrete location or standardized method to document bolus doses
- Multiple versions of protocols on different internal websites (pharmacy, nursing, and Epic) on our corporate network
- Some hyperlinks in Epic directing staff to outdated protocols
- No method to document second nurse verification for high risk medication administration

An interdisciplinary team was established to address all identified root cause analysis issues, as follows:

- Single heparin order set and protocol standardized throughout all care settings (Figure 1)
- All protocol links consolidated to point to single, updated protocol (Figure 1)
- Standardized method to document all heparin bolus doses (Figure 2)
- Development and implementation of second nurse verification work flow for heparin and other high risk medication administrations (Figure 3)
Core Case Study: Clinical Value

The MetroHealth System (Cleveland Ohio)

Figure 1 – Electronic health record screen shot of single standardized heparin order set with consolidated protocol link

Figure 2 – Electronic health record screen shot of standardized method to document all heparin bolus doses (continuous, bolus and PRN)

Figure 3 – Electronic health record screen shot of dual RN sign-off developed and implemented for heparin and other high-risk medications
Evidence of Value

In 2011, the year the heparin sentinel event occurred, MHS had 3 PSN Heparin related errors with patient harm. Since identifying and addressing all root cause analysis issues, no PRNs related to patient harm from heparin have occurred in MHS (Figure 4).

![PSN Heparin Errors With Harm](image)

*Figure 4 – Patients Safety Network (PSN) reports of Heparin Errors causing patient harm (2011-2014)*

Health IT Value Example: Code Status Reconciliation

Brief Overview

The Code Status Reconciliation value case primarily demonstrates prevention from the HIMSS STEPS model, but also demonstrated the long-term potential for increased patient satisfaction and improved clinical outcomes. After a critical event in our health system in which a patient’s code status was not honored, MHS evaluated ways to decrease the chance that a patient’s code status would not be honored in the future. MHS realized that code status reconciliation, especially at discharge from the inpatient setting, when the inpatient code status does not match the prior to admission code status, was a significant opportunity for reconciliation of non-medications (in the same way that hospital discharge is a very important opportunity for medication reconciliation). We implemented standard clinical decision support functionality within our Epic electronic health record to prompt the discharging physician if the inpatient code status did not match the prior to admission code status and force the physician to reconcile the code status (Figure 1). Implementation of code status reconciliation at discharge has significantly increased non-full-code code status within the patients’ record at/after discharge (10% for do not resuscitate comfort care arrest do not intubate and 50% for do not resuscitate comfort care arrest intubate).

![Code status reconciliation clinical decision support at discharge](image)

*Figure 1 – Code status reconciliation clinical decision support at discharge*
Evidence of Value

The overwhelming majority of patients have the same code status prior to hospitalization as they do during their hospitalization, which is most commonly a full-code code status. The goal of code status reconciliation is to ensure that code status changes during an inpatient admission (most commonly changing from a full-code code status to a non-full-code code status) are honored. Figure 2 shows the change in non-full-code code status among outpatients before and after code status reconciliation clinical decision support (red arrow) was implemented (immediate outcome measure of code status reconciliation). Figure 3 shows the change in non-full-code code status before and after code status reconciliation clinical decision support was implemented (red arrow) in new admissions (long-term outcome because the reconciled code status at discharge now continues to be apparent at re-admission/re-presentation).

![Figure 2](image1.png)

**Figure 2** – New outpatient non-full-code code statuses per month before and after code status reconciliation clinical decision support was implemented in 2/2014 (red arrow)

![Figure 3](image2.png)

**Figure 3** – Non-full-code code status at readmission/re-presentation to inpatient/ED settings per month before and after code status reconciliation clinical decision support was implemented in 2/2014 (red arrow)
Health IT Value Example: Outpatient Depression Screening

Brief Overview

The Depression Screening value case exemplifies treatment/clinical care improvement from the HIMSS STEPS model for patients with depression using the electronic health record (EHR). MHS did not have a quantitative, reproducible and systematic way to screen for depression. Therefore, in the spring/summer of 2013, the MHS implemented a suite of tools and processes in our EHR to routinely screen annually all adult patients presenting to primary care appointments using the validated PHQ-9 depression screening tool. EHR tools and process included:

1. Automatic printing of the PHQ-9 tool on pre-visit summaries at check-in (Figure 1)
2. Development of specialized EHR section for entry of PHQ-9 patient reported data (Figure 2)
3. Clinical decision support for provider for identification of patients with “positive” PHQ-9 screening scores (Figure 3)
4. Smart sets for providers to drive evidence based care for patients with “positive” PHQ-9 screening scores (Figure 4)
5. Automatic After Visit Summary educational materials for those patients with “positive” PHQ-9 screening scores

Figure 1 – Example of PHQ-9 pre-visit questionnaire automatically printed for appropriate patient at check-in

Figure 2 – Electronic health record screen shot of specialized PHQ-9 patient reported data collection tool
Evidence of Value

We analyzed the overall impact from September 2013 through December 2014, comparing depression screening and treatment after the implementation of advanced clinical decision support for patient subjective PHQ-9 data collection for depression screening. During this period screening rates increased by 15 fold and depression detection increased by 230% (6.45% to 14.87%). Figure 5 shows the number of PHQ-9 SmartForms completed overtime.

Figure 5 – PHQ2/9 SmartForm use throughout the MHS over time. The PHQ2/9 was first built into our Epic system in the beginning of 2012 (red arrow). Use was very limited until a system of PHQ2/9 use and staff education was provided, which occurred in the spring/summer of 2013 (red horizontal line).
Health IT Value Example: Vaccine Adverse Event Reporting

Brief Overview

The Vaccine Adverse Event Reporting combines treatment/clinical care improvement, electronic secure data exchange and population management aspects of the HIMSS STEPS model. All providers are responsible for evaluation of and reporting to the Centers for Disease Control and Prevention (CDC) possible, probable and confirmed adverse vaccine events. However, many studies document that 1) providers miss vaccine adverse events and 2) even if a provider identifies a possible/probable/confirmed vaccine adverse event they are not aware of the requirement of report to the CDC and/or are not aware of how to report to the CDC. We were the first site in the US to develop a system using the open-source Electronic Support for Public health (ESP) platform (http://www.esphealth.org) connected with our Epic electronic health record (EHR) to identify and report vaccine adverse events. Daily ETL (extract, transform and load) feeds occur between ESP and our EHR including demographic, diagnoses, immunization and laboratory information. Intelligent algorithms in ESP identified possible and probable vaccine adverse reactions. Probable vaccine adverse reactions were sent directly to the CDC vaccine adverse reporting system, along with a message back into the provider’s in basket in the EHR notifying them that the vaccine adverse reaction had been detected and sent. Possible vaccine adverse reactions were sent into the provider’s in basket (Figure 1) in the EHR for one-click confirmation/verification prior to being sent to the CDC.

Evidence of Value

Over the first year after implementation of the vaccine adverse event reporting system (VAERS) functionality, a 30 fold increase in vaccine adverse event reporting was found (Table 1). Details of this system, its implementation and results can be found in our publication in Clinical
Infectious Disease – Advanced Clinical Decision Support for Vaccine Adverse Event Detection and Reporting.

<table>
<thead>
<tr>
<th></th>
<th>VAERS Reports</th>
<th>Time</th>
<th>Reports/Month</th>
<th>Vaccinations</th>
<th>Reports/100,000 Vaccinations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retrospective Control</td>
<td>3</td>
<td>2 years</td>
<td>0.11</td>
<td>274,080</td>
<td>1.09</td>
</tr>
<tr>
<td>Post-Implementation</td>
<td>32</td>
<td>1 year</td>
<td>4</td>
<td>91,622</td>
<td>34.9</td>
</tr>
</tbody>
</table>

Table 1 – Comparison of vaccine adverse event reports during the retrospective control period compared to the post-implementation data period.

Health IT Value Example: Automated Patient Clinical Messaging

Brief Overview
The Automated Patient Messaging value case primarily demonstrates a patient engagement and population management case from the HIMSS STEPS model, but also exemplified treatment/clinical and patient satisfaction. It has also had a positive financial impact. In line with overall MHS efforts to improve population health, MHS has increased the utilization of automated messaging reminders to patients to complete recommended clinical activities such as health maintenance measures (e.g. vaccinations) and laboratory and imaging testing. These measures built upon initial efforts that utilized automated messaging for appointment reminders. To date we have developed automated patient clinical messaging programs in the following areas:

- Adolescent immunizations (automated texting, automated calls and personal health record reminders [2012])
- Adult immunizations (automated texting, automated calls and personal health record reminders [2013], also special data entry linked personal health record reminders for annual influenza vaccines [2014])
- Laboratory tests (automated texting and automated calls [2012])
- Radiology tests (automated texting and automated calls for advanced imaging [2014], also special personal health record messaging with self-scheduling for breast imaging [2015])

Evidence of Value

Adolescent Immunization Messages
After implementing a full suite of best practice advisories and clinical decision support tools in Epic for all pediatric immunizations (which subsequently became an Epic Corporation Clinical Program in 2013), we leveraged this electronic health record “registry” of adolescents overdue for at least one immunization (DTaP, MCV or HPV) to message (automated texts, automated phone call or automated post-card) these patients/their parent using a third-party vendor (TeleVox). MHS studied the impact of messaging on immunization completion rates within six months of messaging from April 2012 to March 2013. The “number needed to message” was approximately four (i.e. send messages to four patients/parents in order to have one patient/parent, receive the message, schedule an appointment, come to the appointment and receive their missing immunization). The development of the infrastructure for this work was
funded by a $150,000 grant from the Society of Adolescent Health. Once the infrastructure was built, we spent ~$5,000 in messaging expenses to bring in ~$200,000 in increased net revenue (ongoing ~$17,000/month net ROI in 2015 dollars). Because of the success of this project during the grant period, which ended in 2013, we have continued this patient/parent messaging and plan to continue for the indefinite future. The details of this project were recently published in the Journal of Adolescent Health – Direct Messaging the Parents/Guardians to Improve Adolescent Immunizations. In addition to the significant increase in immunizations (tens of thousands of immunization have been given as a result of immunization messages to date) and revenue (hundreds of thousands of dollars have been generated because of immunization messages to date) we have also had numerous anecdotal stories of how patients/parents “love that we are reminding them/communicating with them/thinking about them” outside of a face-to-face visit.

**Adult Immunization Messages**

Adult immunization patient clinical messages were implemented in the second half of 2013 for HPV, Zoster, Pneumococcal vaccines, based on the MHS’s experience and infrastructure built for adolescent patient clinical messages. Table 1 shows the impact of automatic patient clinical messages for adult immunizations. Adult immunization patient clinical messages are estimated to be contributing to an additional 1,140 adult immunizations per month throughout MHS, contributing to an estimated ~$10,000/month in additional net revenue.

In the fall of 2014, we also sent 14,744 personal health record messages for flu shot reminders. Although using the personal health record to send patient clinical messages is not unique, we were one of the first Epic customers to enable patients to report external flu vaccine (i.e. flu vaccines obtained outside of our healthcare system) through MHS flu shot reminder clinical messages (Figure 1). 684 patients (4.63%) report external flu vaccines. MHS efforts using personal health records to have patients enter external immunization data has been written up by our EHR vendor as a model clinical program as part of their Success at Seven program ([https://galaxy.epic.com/Search/GetFile?url=1%2168%21100%213076248](https://galaxy.epic.com/Search/GetFile?url=1%2168%21100%213076248)). MHS subsequently expanded personal health record immunization reminder messages with patient data entry for all adult immunizations. Figure 2 shows the results of patient entered data among the 12% of patients who responded with patient data entry.

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Period</th>
<th>Total</th>
<th>Zoster</th>
<th>TDAp</th>
<th>Pneumococcal</th>
<th>HPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline (average/month)</td>
<td>Jan-Apr</td>
<td>2078</td>
<td>110</td>
<td>1274</td>
<td>510</td>
<td>184</td>
</tr>
<tr>
<td>HMRs*</td>
<td>June</td>
<td>3001</td>
<td>228</td>
<td>1910</td>
<td>603</td>
<td>179</td>
</tr>
<tr>
<td>BPAs/Ssets**</td>
<td>August</td>
<td>3218</td>
<td>380</td>
<td>1985</td>
<td>644</td>
<td>209</td>
</tr>
<tr>
<td>% Impr. over baseline***</td>
<td></td>
<td>54%</td>
<td>245%</td>
<td>56%</td>
<td>26%</td>
<td>14%</td>
</tr>
<tr>
<td>Estimated ongoing additional</td>
<td></td>
<td>1140</td>
<td>270</td>
<td>711</td>
<td>134</td>
<td>25</td>
</tr>
</tbody>
</table>

* - Health Maintenance Reminders (HMRs) implemented 5/10/2013
** - Best Practice Advisories (BPAs)/SmartSets (Ssets) implemented 7/12/2013
*** - As measured in 8/2013

Table 1 – Impact of adult immunization automatic patient clinical messages
Figure 1 – Data entry form in the PHR for patients to enter external flu vaccines

Figure 2 – Results of patient entered immunization data among the 12% of patients who entered data in response to a personal health record immunization reminder for the five common adult immunizations

Laboratory Patient Clinical Messages

For laboratory patient clinical messaging, we messaged (automated phone calls starting in 2012 and automated text messaging starting in 2014) all patients one time who have had a laboratory test that had been ordered, but not resulted within three weeks. We then measured the completion of the test during the fourth week at baseline and with messages. We periodically pause messaging to re-evaluate the effectiveness of this program. Table 2 shows the laboratory messaging evaluation over time. We have estimated that in addition to the better care provided as a result of laboratory test reminders, increases in treatment/clinical
The MetroHealth System (Cleveland Ohio) care provided by laboratory test reminder messages results in ~$6,500 per week ($26,000 per month) in additional laboratory revenue.

<table>
<thead>
<tr>
<th>Evaluation Date (sample size)</th>
<th>Baseline Completion Rate</th>
<th>Automated Phone Calls Completion Rate</th>
<th>Automated Text Messages Completion Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>6/2012 (200)</td>
<td>23%</td>
<td>36%</td>
<td>n/a</td>
</tr>
<tr>
<td>9/2012 (643)</td>
<td>n/a</td>
<td>43%</td>
<td>n/a</td>
</tr>
<tr>
<td>2013 (200)</td>
<td>8%</td>
<td>21%</td>
<td>n/a</td>
</tr>
<tr>
<td>11/2014 (100)</td>
<td>n/a</td>
<td>50%</td>
<td>30%</td>
</tr>
<tr>
<td>1/2015 (100)</td>
<td>n/a</td>
<td>34%</td>
<td>24%</td>
</tr>
<tr>
<td>2/2015 (100)</td>
<td>n/a</td>
<td>44%</td>
<td>38%</td>
</tr>
<tr>
<td>Average</td>
<td>16%</td>
<td>38%</td>
<td>31%</td>
</tr>
</tbody>
</table>

*Table 2 – Impact of automated phone and text messages on laboratory completion rates*

**Radiology Patient Clinical Messages**

**Advanced Imaging (CT, ultrasound, fluoroscopy, nuclear medicine, bone density and MRI)**

For radiology patient clinical messaging, starting in March 2015 we messaged (automated text or automated phone call) all patients on days 1, 8 and 15 if they have had advanced imaging (CT and MRI) orders that have not been completed or scheduled to be completed. Figure 2 shows the impact of radiology patient clinic messages. Radiology patient clinical messages had led to an average increase of 44/month more advanced imaging tests occurring post-implementation (177 total more tests finalized than otherwise expected during the four-month post-implementation period) (and 71/month more advanced imaging tests scheduled; 284 total more tests scheduled than otherwise expected during the four-month post-implementation period). The increase in the number of completed radiology tests has led to ~$10,000 per month in additional radiology revenue.

**Breast Imaging (screening mammography, diagnostic mammography and ultrasound)**

Starting in March 2015 when a woman who had a personal health record account was ordered a screening mammogram, a diagnostic mammogram or breast ultrasound they received a message in their after visit summary and through their personal health record that the test had been ordered and that they could schedule the test themselves through their personal health record.
record account. Figure 3 shows the impact of the messaging and ability to self-schedule breast imaging. Personal health record messaging and self-scheduling had led to an average increase of 147/month more breast imaging (586 total more tests finalized then otherwise expected during the four-month post-implementation period) (and 190/month more breast imaging tests scheduled; 586 total more tests scheduled then otherwise expected during the four-month post-implementation period). The increase in the number of completed breast imaging tests leading to ~$5,000 per month in additional radiology revenue.

![Figure 3 - Pre-Finalized and Pre-Scheduled orders (number and linear trend) versus Post-Finalized and Post-Scheduled orders (number and linear trend) before and after self-scheduling of breast imaging was implemented in the personal health record beginning in March 2015](image)

Health IT Value Example: Internal Referral Completion

**Brief Overview**

The Internal Referral Completion case demonstrates treatment/clinical care, patient engagement and population management, and revenue generation from the HIMSS STEPS model. In the summer 2011, throughout the MHS, ambulatory patient volume was not meeting expectations. We leveraged our electronic health record (EHR) infrastructure and the fact that as an integrated healthcare delivery network, we are our own biggest source of referrals. Throughout the MHS we identified that only 48% of all of our consult and procedure referrals were completed or scheduled to be completed within 30 days of the referral order being placed into the EHR. In the beginning of 2012, the MHS implemented a system that identifies consult and procedure referral orders placed in the EHR for which the appointment was not complete or scheduled to be completed within 24 hours. These patients lists (Figure 1) are sent every business day to the referred area for them to reach out directly to the referred patients. Recently, the MHS began to convert this semi-manual process into more automated processes using advanced functionality within the EHR including advanced visit types, schedulable orders and referral work queues.
Evidence of Value

During the first year of this initiative a total of 61,939 consults and 18,936 procedures were completed/scheduled to be completed (an average of ~6,700 additional visits per month). A financial analysis evaluated the net revenue per month of these additional visits. Figure 2 shows the number of consult appointments, procedure appointments, and total appointment scheduled based on our referral completion initiative from Week 1 (February 2012) through Week 55 (February 2013). Significant dips can be seen during holiday weeks (week 43 – Thanksgiving and weeks 47 and 48 – Christmas and New Year’s).

Figure 2 – 56-week analysis of additional consult appointments, procedure appointments and total appointments scheduled through the referral completion initiative
Health IT Value Example: Common High Risk/High Cost Hospital Acquired Infections

Brief Review

The Common High Risk/High Cost Hospital Acquired Conditions case exemplifies treatment/clinical care and costs savings from the HIMSS STEPS model. For over 5 years the MHS has had regular combined Center for Quality and Information Services/Informatics meetings (typically weekly to every other week). One of the primary priorities of having these teams meet has been to implement a range of technology tools to improve (decrease) hospital acquired infections. Over time, these teams have worked on numerous quality related initiatives from an EHR perspective while equivalent teams have worked to address hospital acquired infections from non-electronic health record perspectives. From an electronic health record perspective, primary tools have included:

- Disease/condition specific order sets designed to decrease hospital acquired infections (Figure 1 and Figure 2).
- Best practice advisory designed to decrease hospital acquired infections (Figure 3).
- Improved documentation tools for appropriate care documentation (Figure 4 and Figure 5).

![Figure 1 – Electronic health record screen shot of Mechanical Ventilation Order Set implemented 11/2013 as part of EHR strategy to decrease Ventilator Associated Pneumonia rates](image-url)
Figure 2 – Electronic health record screen shot of nurse driven Foley removal protocol order implemented 11/2014 as part of EHR strategy to decrease Catheter Associated Urinary Tract Infection rates

Figure 3 – Electronic health record screen shot of best practice advisory clinical decision support alert to providers implemented 09/2011 as part of EHR strategy to decrease Catheter Associated Urinary Tract Infection rates

Figure 4 – Electronic health record screen shot of nursing Ventilator Associated Pneumonia documentation tool implemented 04/2013 as part of EHR strategy to Ventilator Associated Pneumonia rates

Figure 5 – Electronic health record screen shot of nurse driven Foley removal documentation tool implemented 11/2014 as part of EHR strategy to decrease Catheter Associated Urinary Tract Infection rates
Evidence of Value

Over the last 5 years, efforts that combine electronic health record/technology interventions with non-electronic health record/technology interventions through the working together of various, typically siloed teams (IT/Informatics, quality, nursing, physicians, infection control, respiratory therapy, etc.) have produced significant decrease in catheter associated urinary tract infection (CAUTI) (Figure 6) and ventilator associated pneumonia (VAP) (Figure 7). In the last 5 years, based on all of the CAUTI and VAP infections prevented (Figure 8), these interventions have saved at least several lives and decreased costs by $7.6 million dollars, based on preventing 305 infections at a typical average estimated cost of $25,000 per infection. On an ongoing basis, 102 infection are prevented, $2.6 million dollars are saved and at least one life has been saved.

![Figure 6](Image)  
*Figure 6 – Trend in catheter association urinary tract infections over time - red arrows indicate EHR tool interventions*

![Figure 7](Image)  
*Figure 7 – Trend in ventilator associated pneumonia over time - red arrows indicate EHR tool interventions*
Health IT Value Example: Improved Core Measures

Brief Review

The Improved Core Measures value example demonstrates the treatment/clinical part of the HIMSS STEPS model. For over 5 years the MHS has had a regular combined Center for Quality and Information Services/Informatics meetings (typically weekly to every other week). One of the primary priorities of having these teams meet has been improvement of The Joint Commission/Centers for Medicare and Medicaid Core Measures. Over time, these teams have worked on Core Measures related initiatives from an EHR perspective, while equivalent teams have worked on Core Measures from a non-EHR perspective. From an EHR perspective, two examples of EHR Core Measures related tools have included:

- Development of smarttext and processes to automatically print appropriate patient discharge instructions for congestive heart failure patients onto printed discharge instructions
- Development and routine use of an alcohol use screening tool for inpatient psychiatric patients

Evidence of Value

Figure 1 and Figure 2 track two core measures over time (one for heart failure and one for inpatient psychiatry) and show the temporal improvement correlated with specific EHR interventions. In the congestive heart failure discharge instructions example, the EHR intervention has provided a sustained 10-15% improvement (86% to over 95% compliance) in the core measure score (Figure 1). In the case of the inpatient psychiatry screening for alcohol abuse example, the EHR intervention has sustained a more then 25% improvement (78% to over 95% compliance) in the core measure score (Figure 2).
Core Case Study: Clinical Value

Figure 1 – Heart Failure Core Measure Discharge Instruction measure (HF1) over time (2009-2014) with impact of electronic health record discharge instruction smarttext implemented in the spring of 2011

Figure 2 – Inpatient Psychiatric Facility Quality Reporting (IPFQR) Core Measure Alcohol Use Screening measure (IPFQR Sub1) over time (2009-2014) with impact of electronic health record screening tool implemented in the spring of 2014

Health IT Value Example: Blood Pressure Diagnosis Research and Improvement

Brief Review

One early “research” success of the MHS EHR, which exemplifies the treatment/clinical and prevention parts from the HIMSS STEPS model, was the ability take isolated clinical observations and efficiently see if they were generalizable to the larger healthcare system. In 2006, the director of the MHS Pediatric Nutrition, Exercise and Wellness (NEW) Lifestyles Weight Management program had the isolated clinical observation that a significant proportion of the children referred to the Pediatrics NEW Lifestyles Weight Management program appeared to have undiagnosed pediatric hypertension. Two Case Western Reserve University School of Medicine students and an informatics fellow took this clinical observation and were able to efficiently pull data from throughout the MHS EHR to demonstrate that approximately
only 25% of children with blood pressures in the EHR meeting criteria for hypertension have had their hypertension diagnosed (75% undiagnosed). This finding resulted in a landmark *JAMA* article, *The Underdiagnosis of Hypertension in Children and Adolescents*, which was designated as one of the top 10 research advances in all of stroke and cardiovascular medicine in 2007 by the American Heart Association. The equivalent study in adults shows that approximately 15% of adult hypertension is undiagnosed as well.

Having used the MHS EHR to identify significant opportunities in the diagnosis of pediatric and adult hypertension, MHS clinical informatics staff then undertook, with the help of grant funding from the Kaiser Foundation of Ohio, to develop tools and methods to improve accurate blood pressure readings and diagnosis of hypertension in children and adults. The first critical step to clinical decision support for blood pressure diagnosis was the recognition that there may be inaccuracies in the blood pressure measurement itself which should be identified, with the person entering the blood pressure value immediately notified. The Epic EHR did not have this immediate evaluation and feedback functionality for entered flowsheet rows, so the MHS worked with the Epic Corporation to develop this functionality for all flowsheet rows, which was used for real-time blood pressure entry validation (Figure 1). If blood pressure values continued to be high in the EHR, clinical decision support alerts were also shown to providers highlighting abnormal blood pressures, showing prior blood pressures and identifying potential evidence based next steps for the evaluation and management of abnormal blood pressure (Figure 2 and Figure 3). These “cascading” alerts (at the time of data entry and then at the time of clinical decision making for patient care) were designed to follow the five rights of clinical decision support to the greatest degree possible: the right information, to the right person, in the right intervention format, through the right channel, at the right time in the workflow.

![Figure 1 – Electronic health record screen shot of “real-time” clinical decision support alert if an abnormal pediatric or adult blood pressure is entered into the EHR](image-url)
Figure 2 – Electronic health record screen shot of provider clinical decision support (CDS). CDS includes current blood pressure value, prior blood pressure values, hypertension and pre-hypertension definitions and links evidence based orders and guidelines for the diagnosis and management of pediatric hypertension.

Figure 3 – Electronic health record screen shot of provider clinical decision support with single click evidence based actions for diagnoses, charting notes, and orders for children who appear to have undiagnosed hypertension.
Evidence of Value

As expected, the EHR tools had an impact on the quality of the blood pressure data into the EHR as well as the diagnosis of hypertension. Among the pediatric population, 41% of blood pressures initially entered as high ended up being reported as normal. Among the adult population, 21% of blood pressures initially entered as high ended up being reported as normal. Therefore, the “real-time” notification of abnormal blood pressures at the time of data entry into the EHR has a significant impact on the quality of blood pressure in the EHR by causing the blood pressure to be validated, during which time a significant percentage of the blood pressures end up not being abnormal.

Among the pediatric population that has abnormal blood pressure, 58% of the time the abnormal blood pressure was recognized, as opposed to the approximately 25% of the time prior to the pediatric blood pressure diagnoses support being implemented.

Lessons Learned

Over the last 15 years, the MHS has learned that EHRs specifically and HIT generally can be a huge tool for administrative, clinical, financial, operational and quality improvement. However, EHRs/HIT just provides the tool. The potential of these tools will only be realized through focused, ongoing, inter-disciplinary teams with a commitment to continuous improvement.

Key lessons include:

- Although the specific details of projects enhanced/catalyzed by EHRs/HIT will differ, generalizable needs exist across EHR/HIT catalyzed projects including:
  - Dedicated, inter-disciplinary teams
  - Methodology around project governance, project management, project scope and project timelines
  - Standard processes for designing, building, testing, training, implementing and optimizing technology solutions
  - Commitment to plan, do, study, act (PDSA) (or similar) continuous improvement processes

- Need to commit to stay abreast of enhancements/changes in EHR (Epic) functionality
- Need to commit to stay abreast of what other Epic customers are doing
- Need to commit to stay abreast of larger trends in health IT and informatics specifically and healthcare generally
- Aligning EHR/HIT activities/initiatives around the overall clinical, business and academic mission of healthcare system