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**A Community-Shared Clinical Abstract to Improve Care**

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# Abstract

**Purpose:** to enhance care during transitions from community to emergency departments (ED) by using health information exchange (HIE) to make prior clinical information from electronic medical record (EMR) systems accessible to ED clinicians.

**Scope:** In 2003 three Twin Cities-based healthcare systems set out to investigate HIE to share prior clinical information of ED patients and to evaluate the impact of that sharing. Once it became clear that barriers would make it impossible to implement HIE during the study period, we adopted a stand-in for HIE, the presence of prior clinical information in the healthcare system's own EMR for patients presenting to the ED.

**Methods:** An observational study of patients with congestive heart failure (CHF) presenting to an ED in each health system was conducted to assess the effect of prior information on care quality and efficiency measures. Data were collected from the billing and clinical records of each healthcare system. A patient's first appearance in an ED during the observation period constituted an index case. Index cases were classified as Internal if prior electronic clinical information was available or External otherwise.

**Results:** After adjusting for age, gender, race, marital status and comorbidities, Internal patients in one of the settings were found to have had fewer orders for lab tests and medications while in the ED, lower odds of hospitalization, and if hospitalized, lower odds of mortality than External. Once multiple barriers to HIE are overcome, it can become a valuable adjunct in the care of patients coming to the ED.

**Key Words:** health information exchange, electronic medical records, emergency department, care transitions

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# Final Report

## Purpose

We set out to enhance continuity of care during care transitions from the community to the hospital emergency department (ED) by using a health information exchange (HIE) model. This particular care transition can be especially troublesome when a patient in acute distress suddenly arrives with little historical clinical information readily at hand. To fill critical information gaps, we planned to access outside electronic medical record (EMR) systems and deliver prior clinical information in the form of a succinct clinical abstract to ED providers and thereby improve patient care. We designed a study to measure the effect of the availability of additional clinical information on measures of care quality and clinical management efficiency.

## Scope

### Background

Changes in health status drive care transitions between home, community and healthcare settings. Care transitions are associated with information gaps, communication breakdowns, and lack of coordination which can lead to inefficiency, errors, safety risks, redundant effort, and patient dissatisfaction. Transitions to the hospital emergency department (ED) are especially problematic due to the urgency of the presenting problems and the limited objective clinical information available. If the transition is driven by a sudden and unexpected event at home or the workplace, the patient is likely to arrive in the ED with no readily-accessible, prior clinical information. In one metropolitan setting information gaps occurred in a third of patients presenting to the ED with clinicians rating the importance of the missing information as very important or essential in 48% of the cases. The most vulnerable - older, more seriously ill patients and those with serious chronic illnesses - experienced the gaps. Gaps were associated with prolonged stay and increased costs of redundant testing and other assessments. But addressing these information gaps is not easy. In a survey of ED physicians, 86% of respondents rated it difficult or extremely difficult to obtain additional clinical information from outside providers and that their attempts to obtain such information failed more than half of the time. Perhaps not surprisingly, 56% indicated that they would request such information for less than 10% of their cases.

Health information technology holds promise to close such gaps leading to improved care quality and efficiency. When ED physicians had access to an electronic medical record (EMR), redundant tests and poor drug choices were reduced.(Stair, 1998) Overhage reported an average savings of \$26 per ED visit in one Indianapolis hospital in which ED physicians were provided access to an EMR or a printed abstract of the record.(Overhage, 2002) But free access to complete electronic clinical records may not meet the needs of busy ED providers. In one study, ED physicians rarely attempted access to a shared electronic record because of time pressures

and password difficulties preferring the use of a printed abstract of the record.(Overhage, 2002) In a city-wide survey of ED physicians in New York City, over half of the respondents anticipated that the time to a disposition decision would increase or greatly increase with the availability of additional clinical information.(Shapiro, 2007) Hripesak reported that even when ED physicians knew of the availability of additional clinical information in their own familiar EMR system, such data were accessed less than half the time.(Hripesak, 2007) Not that prior records can or should always be inspected. The urgency of some ED situations may make it impossible to review such data in a timely manner. In some situations (e.g., massive trauma), the potential contribution of prior history to understanding and stabilizing the acute situation may be minimal. In a small study of the information needs of emergency physicians, the most frequent diagnoses presenting to the ED were not seen as the ones that would benefit the most from additional prior clinical information. Currently ED physicians face a decision dilemma with regards to seeking and using additional clinical information.

Health information technology may soon provide a solution to this dilemma. In recent years enthusiasm has grown for the broad deployment of EMR systems that are interoperable (i.e., they can share information between systems and use that information) and interconnected to facilitate health information exchange (HIE) at a community, regional or national level. Indeed, the United States is in the midst of a national quest to achieve this.(Blumenthal, 2010) Conceptually, HIE can provide a timely, dependably-structured and succinct summary of prior clinical information at little cost of provider effort or time.

## **Context**

In 2003 three large healthcare delivery systems in the Twin Cities that had or were about to install an EMR system from the same vendor to support all or part of their clinical operations foresaw the potential to transfer clinical information among those health systems. They joined in an effort to determine if sharing additional clinical information for patients with congestive heart failure (CHF) who appeared in their EDs would have an impact on clinical care and outcomes. CHF was selected in that it is a common chronic illness with exacerbations which frequently result in ED visits and re-hospitalization.(Jencks, 2009) It is a costly chronic disease for which prior clinical information is likely to exist and be relevant to clinical decision-making during subsequent visits. In 2007 CHF was the third most common diagnosis in ED patients among those between 65 and 84 years of age and the most common diagnosis for those 85 and older. (HCUPnet, 2010)

## **Setting**

One ED from each health system was selected for observation based on its patient volume, perceived high prevalence of out-of-system patients, metropolitan location, broad geographic coverage, and availability of clinical data in its EMR. Each health system used the same vendor's EMR system to document information about a patient's ambulatory visits, and records from these visits were accessible throughout the health system. Two of the health systems also used the same EMR for inpatients whereas the other ED used a different commercial EMR to document inpatient and emergency care. Clinicians within a health system had access to that system's inpatient and ambulatory records. However, whether or not such records were accessed remained unknown to us. In the context of this study, unless they requested outside records be

faxed, ED providers in these health systems were only able to access clinical information available in the EMR for patients who had previously received care within the health system that operated the ED and thus had clinical records in that health system. We did not preclude ED providers from requesting additional clinical information from outside sources.

## **Participants**

The study sample was drawn from patients visiting two of the selected EDs over a 34-month period from June 1, 2006 to March 31, 2009 and the third over a 19-month period from June 1, 2006 to December 31, 2007. The study sample included all patients 18 years or older who presented to one of the 3 EDs within the timeframe and had an International Classification of Diseases, Ninth Revision - Clinical Modification (ICD-9-CM) code representative of CHF associated with their ED visit.

## **Methods**

### **Study Design**

Our assumption was that ED patients who were new to the health system which operated the ED were more likely to have a greater clinical information gap in comparison to patients who had been cared for by that organization. In theory HIE can fill that gap. This retrospective, observational study employed secondary data analysis to compare these two groups of patients with respect to differences in a number of measures of utilization and outcomes to evaluate the potential benefits of closing this information gap through HIE. Our study protocol was reviewed and approved by the University of Minnesota's Institutional Review Board (IRB) as well as by the IRBs of each of the participating health systems.

### **Intervention**

Based on the vendor's EMR system that each of the participating health systems used, we developed a special health summary report, My Emergency Data (MED), which was to be used as the clinical abstract to be exchanged. The contents of this report were specified by a team of physicians including emergency care providers working in each health system. MED was also made electronically accessible to patients within a health system who registered for on-line access to their electronic record information.

### **Data Sources/Collection**

Each of the three participating health systems used a project-supplied, clinician-reviewed collection of ICD-9-CM codes to identify patients with a diagnosis of CHF in its billing data. Using the resulting patient and encounter identifiers they extracted patient-level and encounter-level data from their data warehouse. Patient-level data included age at the index ED visit, gender, race, marital status, and information about previous visits. Encounter-level data included,

for the index visit, arrival and departure times, ED disposition status, laboratory tests (at the orderable level), diagnostic procedures (e.g., imaging studies and ECGs) and medications ordered, diagnosis codes, and if hospitalized, hospital admission time, discharge time and discharge status. Date/time data were based on system timestamps, and those with unreliable or outlier timestamps were excluded. We excluded 30 patients whose ED length of stay (LOS) was zero hours or exceeded 24 hours as such cases likely represented data entry problems at the source or administrative problems unrelated to clinical issues.

All data provided to the research team were de-identified. Because some of the research data procured and subsequent conclusions could be deemed sensitive in the local competitive healthcare market, it was agreed that the participating ED sites would not be further identified.

The first appearance of a patient during an observation period was designated as the index case and only the data associated with that encounter and any immediate subsequent hospitalization was included in the study.

## **Changing the Intervention**

Our initial plan was to use HIE to transfer prior clinical from the EMRs of the other two health systems to form a succinct abstract that would be electronically delivered to the ED of the health system that was currently seeing the patient. We planned to compare the clinical performance measures (to be described in the next section) of patients for which an abstract with prior clinical information was made available with those for whom no electronic information was available. However, we encountered numerous substantive barriers to implementing HIE which are described in the upcoming Results section. Eventually it became clear that HIE could not be achieved during the funding period.

At that point we formulated a change to our study that would allow examination of the potential impact of HIE prior to implementing it. We focused on a stand-in for HIE, accessible prior clinical information in the health system's EMR. We set out to determine if patients with CHF presenting to the ED who had accessible prior electronic clinical records in that health system's EMR were less likely to experience an information gap and therefore receive different care than did similar patients who had no accessible prior clinical information in the EMR and thus be more prone to experiencing an information gap. Patients with clinical information already electronically available (i.e., Internal patients) would be similar to patients who had experienced HIE. Patients with no such information (i.e., External patients) would represent patients without HIE and would be more likely to experience an information gap.

Patients were classified as Internal if there was evidence of a substantive encounter in the associated health system's EMR prior to the index visit. Encounters involving only medication dispensing or immunization where there was unlikely to be a clinician assessment, diagnosis and/or treatment were not considered to be substantive. Patients with no evidence of a substantive clinical encounter were classified as External. For subsequent statistical analysis we created a binary variable, Internality, which was set to one for Internal patients and zero if External.

## **Clinical Performance Measures**

We hypothesized that the existence of prior clinical information accessible in the EMR would diminish information gaps and be associated with better quality and efficiency of care

compared to patients for whom such information was not available at the time of the index ED visit. We thought that with the availability of useful clinical information such as lists of medications, allergies, and diagnoses, patients would be less likely to experience medical errors and adverse events. This could translate into lower hospitalization and in-hospital mortality rates. As surrogates for quality of care, we used the hospitalization rate, inpatient LOS, and inpatient mortality rate. We excluded ED deaths from further analysis after finding only a single death occurring in any of the EDs during the observation periods. We thought that knowledge of recent laboratory tests and diagnostic procedures might lessen subsequent resource use and that medication lists might limit additional prescriptions. The numbers of laboratory orders, diagnostic procedures and medications ordered during the index ED visit were used as surrogates of resource utilization. We elected to examine ED LOS as there is concern that the time to a disposition decision may be prolonged if there is additional clinical information to review. (Shapiro, 2007)

In order to control for the effects of patients' demographic factors, we included age, gender, race, and marital status in the model. Recognizing that the burden of illness is strongly associated with patient outcomes, we included a Charlson comorbidity index (CCI; Charlson, 1987; Charlson, 2008) based on diagnoses that the patient had during the index ED visit. We used existing algorithms (Deyo, 1992; Quan, 2005) to determine CCI with minor modifications.

## Statistical Analysis

Descriptive statistics were calculated and simple comparisons were conducted using the chi-square test of independence, Wilcoxon's Rank Sum test, and analysis of variance as appropriate. All tests were two-sided.

Logistic regression analysis was used to investigate the influence of Internality on hospitalization and hospital mortality adjusting for effects of age, gender, race, marital status, and CCI. We used a generalized linear model (GLM) to investigate the impact of Internality on ED and hospital LOS adjusting for the same independent variables. Because ED and hospital LOS were highly skewed and residual plots of fitted values and residuals of the ordinary least squares estimates indicated the need to reflect a more appropriate variance structure in the models, we used the modified Park test to identify the proper variance structure for use in the GLM procedure. (Manning, 2001) Because laboratory tests, diagnostic procedures and medications ordered during the ED visit conform to the definition of a count data model, we employed and compared a number of such models including the Poisson, negative binomial, and hurdle models. (Liu, 2008) The model with the best fit was selected based on the Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and the likelihood ratio tests. The SAS software package version 9.2 (The SAS Institute Inc., Cary, NC) was used for all analyses.

## Limitations

We were unable to study the effects of using HIE to gather prior clinical information from outside healthcare systems due to a number of substantive barriers to exchange. These barriers are described in the next section. However, it seems reasonable to expect that a well-formatted report of prior clinical information eventually made available via HIE will have a similar effect to prior information that was already available in the local EMR. Indeed, on a case by case basis

the impact of exchanged data from outside the health system may be greater if its content is more current, complete and novel when compared to locally-available information.

This study is limited by our ability to validate whether a patient classified as Internal was treated as an 'Internal' patient or an 'External' patient (or vice versa). For example, the prior clinical information for a patient that was last seen in the health system five years ago may have had little value with respect to the current situation, yet our algorithm would have classified that patient as Internal. Alternatively, extremely relevant clinical information of a patient classified as Internal could have been available at the time of the ED visit, but might not have been accessed by ED providers. These examples represent possible false positives and negatives with respect to our Internal/External classification system.

Research data collection was challenging because each health system retained key data elements in different forms using different definitions and stored using different data models. Status updates (e.g., marital status) often replaced earlier data so that patient status at any past point in time might not be obtainable by querying a database. One of the participating health systems had more recently deployed their EMR throughout their ambulatory and hospital environments. There the individual who executed the data query on behalf of the study was intimately familiar with all of the recently defined clinical data elements and was able to match the data retrieval specification very effectively to the correct data resources and terms. With such single-point and up-to-date expertise not available at the other sites, implementing the retrieval to match the research specification may have been more problematic. Although each health system had adopted the same vendor's EMR system, each had configured it independently which led to significant heterogeneity among the databases from which the research data were acquired. For example, numbers of laboratory tests, procedures, or medications may contain some artifacts of heterogeneity among the health systems (e.g., different coding systems, different ways a particular order would be entered and represented in the system). A case in point is the differences in the number of medications ordered at the three sites. We found that the site with the lowest number of medication orders reported completed medication orders which excluded those orders that were subsequently cancelled before being filled. Ensuring that the data provided to the research team was properly de-identified led to additional research expense and made data validation more difficult.

## **Results**

### **Principal Findings**

The project's initial intent was to exchange continuity of care documents (CCD) containing the contents of the My Emergency Data report among our 3 selected EDs. This goal appeared feasible after two key standards development organizations, ASTM International and Health Level 7, came to a belated agreement on the underlying standards in early 2007. However, once the CCD standard was assured and endorsed at the national level by the Healthcare Information Technology Standards Panel, the EHR vendor common to the three health systems embarked on a closed exchange strategy which required customer-participants to agree to unlimited geographic scope of exchange rather than regional exchange which was of immediate interest to

our healthcare systems. Privacy and security concerns about the vendor's approach limited our health systems' acceptance of it until recent months.

Momentum towards HIE at both the state level was growing by 2007 which paradoxically proved to impede this project's progress. Minnesota's legislature updated privacy regulations to accommodate HIE but these changes led to uncertainty among the legal counsel of our health systems that stymied decisions to implement HIE. Recognition of the need for an exchange organization in Minnesota led to the "birth" of MN HIE in late 2007. Our project's executive board committed the project to use the nascent HIE once its communication services would become available so as to avoid development of redundant and temporary communication channels. But facing weighty governance, funding, sustainability and staffing issues, MN HIE evolved at a pace too slow to accommodate this project during its funding period. Only late in 2009 did the HIE begin a number of pilot projects involving a single health system.

The national HIT picture has dramatically changed over the term of this project. While health information technology including exchange has attained much higher visibility and substantive federal financial incentives are now driving progress, the temporal prioritization of exchange has not increased. Rather, meaningful use criteria being established by the federal government which will drive deployment of HIT functions, has effectively postponed exchange until 2013 and beyond a full decade after the current project was envisioned. In sum, we encountered multiple significant barriers to HIE which could not be overcome during the funding period. Most of these barriers still remain although national efforts are now bringing about encouraging progress.

Once it became clear that true exchange was not going to be feasible during the project's term, we modified our evaluation plan to focus on two ED patient groups at each of the three participating EDs; Internal patients - those with CHF who already had an electronic clinical record in that health system at the time of their first ED visit during the study period and External patients - those with no available electronic record. There were 5,166 patients designated as index cases with 3,974 (77%) determined to be Internal patients. Comparing patients' demographic factors by Internality, the only pattern consistent across all sites was that Internal patients were more likely to be Caucasian than External patients. Within any one site, there was no difference in the degree of comorbidity between the two patient groups. After adjustment for age, gender, race, marital status and comorbidity, Internality had no effect on either ED LOS or Hospital LOS. Age, race, and CCI were better predictors. At the site with the greatest number of patients, Internal patients had lower odds of being hospitalized and, if hospitalized, lower odds of death in the hospital than External patients. The latter was also true at a second site. Again, at the most active site, Internal patients were estimated to have 6.4% fewer laboratory tests ordered than External patients. At a second site the odds of having zero lab tests were similar for Internal and External patients (p-value = 0.095) but among patients with at least one laboratory test order, Internal patients had 14.9% fewer lab tests than External patients. There were no differences between Internal and External patients in the numbers of procedures that were ordered. Internal patients had significantly fewer medications ordered during the ED visit than External patients at each of the three ED sites with differences ranging from 26% to 35%.

## **Discussion**

We found that patients with CHF who had some electronic clinical information available within a health system when the patient presented to the ED (i.e., Internal patients) had a lower

hospitalization rate at our most active site and, if hospitalized, a lower mortality rate there and at a second site. Internal patients had fewer medications ordered at all three sites, mixed evidence for fewer laboratory tests, but no difference in the number of procedures ordered, ED LOS or, if hospitalized, hospital LOS. These results are consistent with our own earlier analysis of a smaller CHF dataset which included patients with diabetes and asthma. In that study ED patients with CHF and prior clinical records demonstrated a lower hospitalization rate compared to those without available prior records and a similar pattern of reduction in the number of laboratory tests ordered.

Recent broad, national studies of the impact of EMRs on healthcare costs and quality which included heart failure patients have shown little difference between hospitals that have adopted EMRs and those that have not. (Himmelstein, 2010; DesRouches, 2010) However, those studies did not examine patient outcomes with respect to the presence or absence of prior electronic clinical information. In the present study, all participating health systems were EMR adopters, and the study was focused on performance differences within an institution related to the existence or lack of electronic clinical information at the time of presentation to the ED. Because we are dealing with within-hospital variance which likely is smaller than across-hospital variance which Himmelstein and DesRouches were dealing with, our study design is likely to be more sensitive.

Although our Internal and External patients show some systematic differences in demographic makeup, when controlling for these variables, Internal patients had a lower risk of hospital mortality at two of the three sites. By definition the patients with prior clinical information had a previous relationship with the healthcare system that provided the ED service. If that relationship was prolonged and ongoing and if that healthcare system provided better care than the norm for CHF patients, this would likely result in Internal patients being in a better state of health, which is a possible alternative explanation for their lower mortality rate.

On the other hand, the difference detected in both ED and hospital care for Internal patients may have been mediated by the availability of previous clinical information. While in this case the prior information was already within the healthcare enterprise, the current standards underlying interoperability and information exchange are feasible ones to implement and such implementation could enable the transfer of prior information from other healthcare settings. A number of healthcare systems in our community that use the same vendor's EMR system have recently begun exchanging clinical information via a vendor-specific communication link after satisfying their own internal legal and privacy concerns. Since the information they are exchanging includes a succinct summary of the presenting patient's medical history as well as detailed document and results information in a form similar to the receiving system's EMR records, it is reasonable to anticipate that this additional information will lead to benefits similar to those we found when prior clinical information was available.

The clinical impact of health information technology is dependent on the services deployed and many other local contextual issues. So it is not surprising that results varied across such diverse settings as our three EDs each housed in a different health system. That the reduction in mortality and number of laboratory tests and medications were found in at least two of the three EDs strengthens our conclusions.

We were somewhat surprised by the high proportion of Internal patients found at all sites. One of our criteria for selecting the EDs was the expectation that the ED served many patients not associated with the ED's health system such that we would frequently encounter patients that would be classified as External. Our experience may be an artifact of focusing on a chronic

disease such as CHF. CHF patients may tend to return to the same familiar, nearby healthcare facility for emergency care. Therefore, since most CHF cases are prevalent rather than incident, most CHF cases can be expected to be classed as Internal patients even though the ED draws patients from a wide population base. In any event, the resulting imbalance in the number of Internal and External patients that we experienced led to decreased statistical power when making comparisons.

## **Continuing Work**

While the project's primary study results have been largely analyzed and are summarized in this Final Project Report, two additional facets of the work could not be analyzed within the 90-day deadline of this report. We intend to complete that analysis and publish our findings in due course. For Internal patients in one of the EDs, printed clinical abstracts in the form of the MED report were made available to ED physicians during a 12-hour period each day of a three month observation period. This clinical abstract intervention and associated data collection was successfully completed in October 2009. The afore-described analysis is being performed comparing the patient group for which a clinical abstract was printed to the group treated without an abstract. In the second facet of this project yet to be completed, as originally planned, data is being examined to estimate the frequency that patients usually cared for in one system "cross over" to another system's ED as a means of estimating the rate of potentially useful HIE in emergency situations within our community.

## **Conclusion**

By providing electronic access to prior clinical data and thereby diminishing information gaps, there is evidence that HIE could be a valuable adjunct in the care of CHF patients in the ED who are new to a health system as demonstrated by a favorable impact on hospitalization rate, mortality, and resource use. That said, currently there are many significant barriers to HIE including those related to privacy, legal and regulatory issues, work culture change, meaningful use certification, technical standards, and exchange organization governance and sustainability. While progress is being made on these issues, they represent societal challenges which will only be resolved after many years of concerted national and regional effort.

## **Significance**

In that the reduction in mortality and resource use we found was for patients with CHF, the potential economic impact is substantial for a nation that expended nearly \$40B on CHF healthcare in 2007. (Lloyd-Jones D, 2010) In 2007 CHF was the third most common diagnosis in ED patients among those between 65 and 84 years of age and the most common diagnosis for those 85 and older. (HCUPnet, 2010) While this study was focused on patients with CHF, the benefits of using HIE to have prior clinical information readily at hand, should be of value in most clinical situations involving chronic illnesses.

## Implications

It is not yet clear that the fundamental assumption that HIE can improve transitions by bringing useful prior clinical information to bear is universally valid or if the degree of its validity is influenced by any number of factors ranging from patient presenting complaints to clinical workflows. Before we can fully understand the impact of additional prior clinical information at the important transition from the ambulatory state to the ED, better documentation regarding the nature and extent of availability and actual use of additional clinical information is needed.

In future work focused on assessing the impact of HIE, access to prior clinical information by ED physicians should be specifically documented perhaps by monitoring the EMR's audit logs or review of clinical documentation. Other frequently occurring chronic diseases should be studied to better characterize parameters that may make prior information especially useful or not. Prior clinical information for some other chronic diseases than CHF may show a more compelling clinical impact.

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