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# Transformation of Emergency Department processes of care with EHR, CPOE, and ER event tracking systems

Smruti Vartak, Donald K Crandall, Jane M Brokel, Douglas S Wakefield and Marcia M Ward

## Abstract

Mercy Medical Center – North Iowa implemented electronic health records (EHR), computerised provider order entry (CPOE) and event tracking systems in the emergency department (ED) as part of hospital-wide implementation of clinical information systems. This case study examines the changes in outcomes and processes in the ED following implementation. Although the system was designed to enhance efficiency, there was a significant increase in the mean length of stay (about 17 minutes, or 15%) in the ED after implementation. This surprising finding was examined in relationship to the multiple process-of-care changes in the ED.

## Keywords (MeSH):

*Medical Records, Computerised; Electronic Medical Record; Emergency Service, Hospital; Medical Order Entry Systems; Hospital Information Systems; Evaluation.*

The Institute of Medicine has recommended that hospitals should adopt robust information systems to improve the safety and quality of emergency care and enhance hospital efficiency (Institute of Medicine 2006). Clinical information systems in the emergency department (ED), especially electronic health records (EHR), could result in time and cost savings for both patients and physicians (Institute of Medicine 2001; Piasecki et al. 2005; Yoon, Steiner & Reinhardt 2003). Little research has been published on actual experiences with commonly used commercial clinical information systems (Bahensky, Jaana & Ward 2008; Chaudhry et al. 2006; Garg et al. 2005).

Trinity Health is a large multi-hospital health-care system, which owns or manages 45 hospitals. It has chosen several of the nation's largest vendors for a system-wide clinical information system implementation. We used the experience at one of their hospitals to describe the changes in care processes that go along with this type of transformation. This case study is focused on the ED to examine the impact of EHRs,

computerised provider order entry (CPOE), and emergency room (ER) event tracking systems on processes and outcomes. The ED can be viewed as a microcosm of the hospital; hence examining changes in the ED after EHR implementation is in many ways similar to the changes that occur in the rest of the hospital, yet in other ways, the ED is unique. We examined both effects.

## Case description

Mercy Medical Center - North Iowa (MMC-NI) is a not-for-profit community healthcare system, owned by Trinity Health, which offers comprehensive healthcare services for people throughout northern Iowa and southern Minnesota. As the major rural referral center, MMC-NI is a secondary level hospital with 193 staffed beds, more than 2,750 employees and 165 active medical staff members, and averages 13,000 acute discharges and 35,000 ED visits annually.

As part of a system-wide strategy, an implementation model called 'Project Genesis' was developed for health information technology

(HIT) implementation in Trinity Health facilities (Crandall et al. 2007). It was implemented through a standardised and phased methodology (Crandall et al. 2007). Phase One of Project Genesis consisted of installing the central clinical data repository; interfaces for dictated reports, pharmacy system patient drug profiles, and laboratory results; a results viewer (Cerner PowerChart); and an Adverse Drug Event (ADE) rules package. During this time, Trinity Health also implemented an Enterprise Master Person Index system to establish unique patient identifiers for the enterprise-wide systems and the PeopleSoft Enterprise Resource Planning (ERP) system. In the second phase of Project Genesis the early interfaces for dictated reports were replaced with full integration within the EHR. A new enterprise-wide patient registration management application and a suite of clinical applications (Clinical Documentation, CPOE with pre developed service specific order sets, a new pharmacy application, medical records profiling for coding and publishing, an ER event tracking system, and radiology system) were implemented across the entire facility including inpatient acute care and outpatient procedural areas. Specifically in the ED, the implementation of the ER event tracking application allowed clinicians to easily view the status of all pending and completed physical exams and diagnostic tests, thus reducing delays and increasing efficiency in managing patient flow. It also provided the ED staff with a quick view of each patient's status through a large display screen in the center of the ED. It worked as an electronic whiteboard, technology which has been shown to reduce delays and increase efficiency in managing patient flow (Aronsky et al. 2008).

MMC-NI was introduced to the preparation milestones for implementation of the EHR in February 2003. The readiness stage took place over the course of 24 months. Preparations included communication and engagement plans for organisational change, participative design decisions for order sets, development of clinical decision support rules, comprehensive process redesign, system content design, user acceptance testing, staff and clinician training, and development of the hospital's infrastructure (e.g. networking and device selection). Rather than an

incremental approach, the Project Genesis plan used a 'Big Bang' approach which consisted of bringing down all the old systems, implementing the new system, inputting current patient data into the new system, and converting users to the new system for all clinical areas at the same time, and over the course of a single weekend (Crandall et al. 2007). MMC-NI went live using the 'Big Bang' approach for Phase Two implementation on July 8, 2005. All systems – clinical documentation, EHR, CPOE with over 250 order sets, 54 clinical decision support rules, ER event tracking, pharmacy alerts and medication list management, medical records system, and patient management systems – were implemented at the same time (Crandall et al. 2007).

## Method

To assess the impact of implementing clinical information systems on processes of care and outcomes in the ED, various data sources were examined. ED discharge abstracts were examined for changes in patient volume. The ED patient visit log files were analysed to examine changes in disposition and patients' ED length of stay (LOS). Records of CPOE adoption rates by physicians were examined to understand the CPOE uptake in the ED compared to the rest of the hospital for the year following activation of the CPOE system. In addition, clinical and information technology leaders within Trinity Health and MMC-NI were interviewed about changes in ED processes related to implementing the clinical information systems.

## Results

### *Analysis of ED log files*

LOS is a key measure of ED throughput and a marker of overcrowding. Six one-week periods of ED LOS, three each from the pre-implementation (October 2004, January 2005 and April 2005) and post-implementation (July 2005, October 2005 and January 2006) periods were analysed by Mann-Whitney U Tests. The mean LOS increased significantly from 116.8 minutes during the pre-implementation period to 134.2 minutes during the post-implementation period ( $p < 0.0001$ ). This change of 17 minutes increased the ED LOS by about 15%. Changes in median

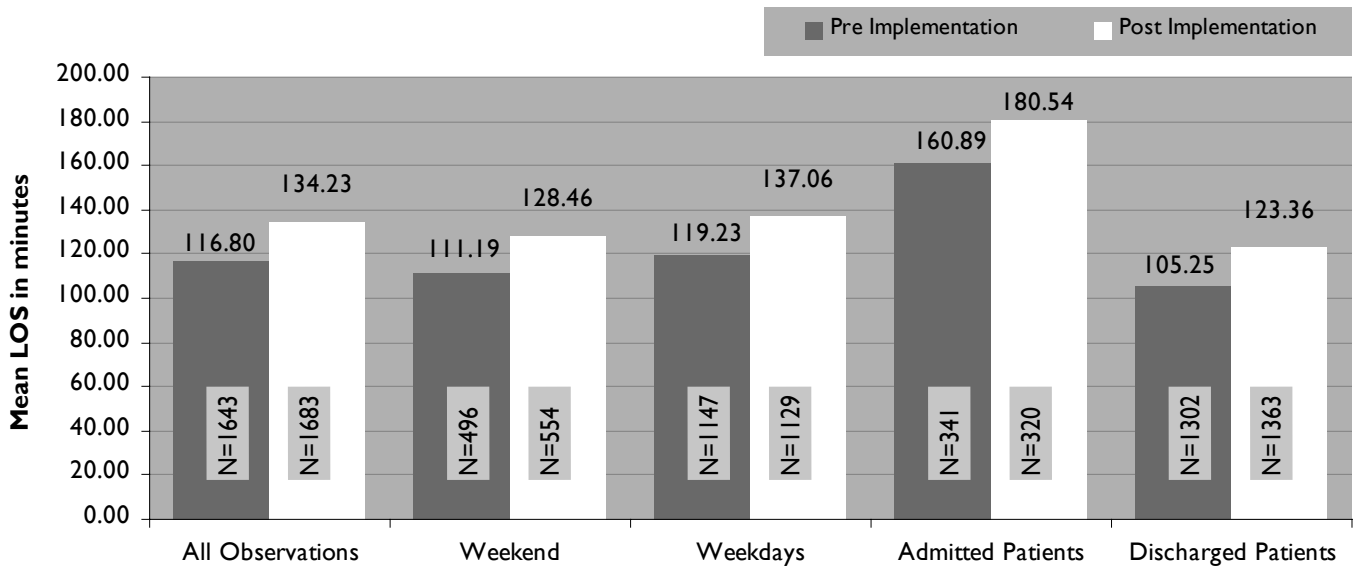


Figure 1: Comparison of ED LOS during Pre-Implementation and Post-Implementation

LOS were similarly significant. As shown in Figure 1, the pattern was consistent across time periods (weekday versus weekend) and patient dispositions (admitted to an inpatient unit versus discharged directly from the ED).

**Analysis of ED discharge summaries**

The annual numbers of patients treated in the ED decreased significantly ( $p < 0.0001$ ) from pre-implementation ( $N = 22,936$ ) to post-implementation ( $N = 18,929$ ).

**Analysis of CPOE adoption rates**

CPOE adoption rates by various subsets of physicians was examined across the first 12 months (August 2005 – July 2006) following implementation (data were available for about 90% of physicians). Analyses were limited to physicians who had at least two months of data for which they wrote at least 50 hospital-based care orders. As shown in Figure 2, CPOE utilisation was about 76% for ED physicians in the first post-implementation month, and 10 months later it increased

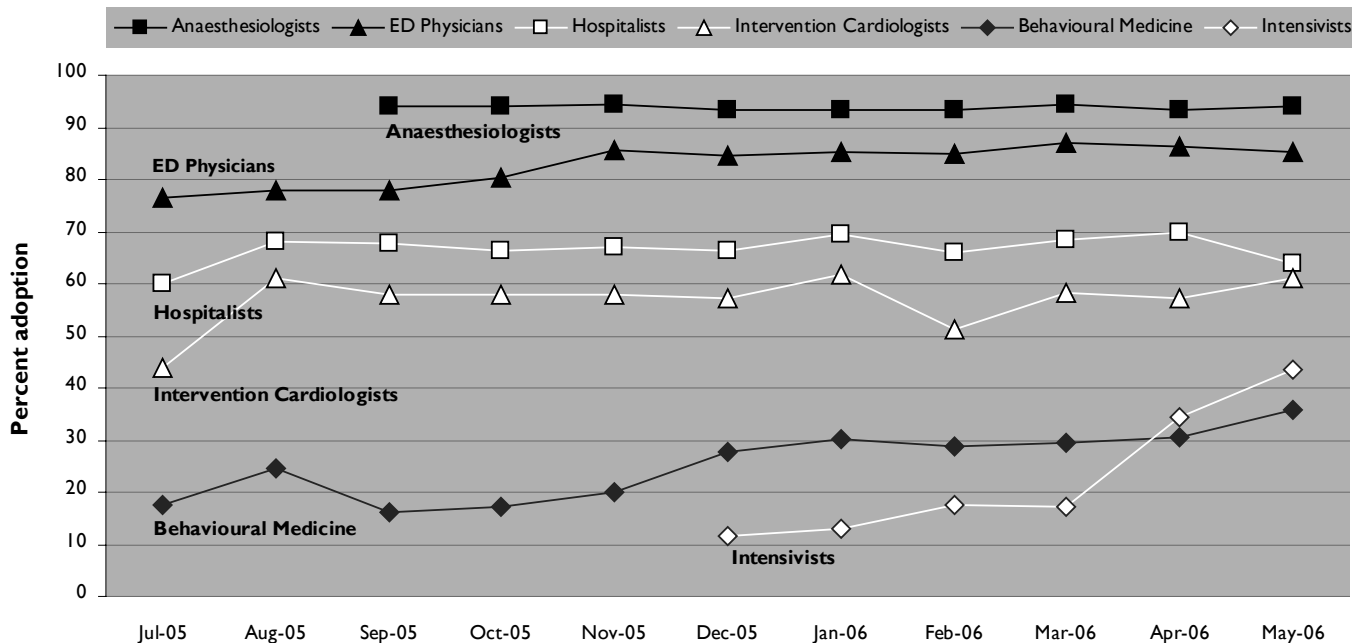


Figure 2: Percent Adoption of CPOE by Different Physician Groups at MMC-NI

to about 87%, among the highest rates across departments.

## Discussion

Along with the implementation of the EHR, CPOE and ER event tracking systems, there were multiple changes in ED processes of care. These extensive changes resulted in an average increase of 17 minutes (15%) in LOS. Analysis of differences across weekdays/weekends and by patient disposition showed the same general pattern, indicating that the increase of 17 minutes on average was not related to any specific work period or patient disposition, and occurred even though ED patient volume declined. The average LOS over the three pre-implementation quarters was quite consistent, whereas the LOS showed some decreasing trend over the three post-implementation quarters, reflecting a goal at MMC-NI.

One of the objectives of EHR implementation with the new patient-centered processes was to reduce the ED LOS by speeding up quick-registration, the triage process, and room assignment. Prior to implementation a patient would typically be seen by a triage nurse and then go to registration where there could be some wait if the ED registration was busy. After EHR implementation, a patient goes directly from triage with quick-registration to an exam room without waiting for full registration procedures. The quick-registration process captures eight items of patient essential data to establish the EHR for a patient at the door or in-route by ambulance/helicopter. The full registration is then completed at the bedside afterwards. This streamlined process should reduce LOS. However, moving the registration earlier in the process at or before the patient arrives on site, may make the LOS appear longer, even though the patient does not actually spend longer in the ED, since the LOS begins when the time stamp is activated at quick-registration and triage.

A number of changes in process of care could have affected ED LOS. First, the introduction of CPOE to ED physicians has been shown to produce inconsistent effects on LOS (Overhage et al. 2001; Mekhjian et al. 2002). Second, interviews with ED staff suggested a significant increase after implementation in the number of diagnostic tests and consultations being ordered

by the ED physicians. Third, ED LOS for patients admitted to inpatient units is dependent on non-ED physicians because of privilege constraints. This can remove control of certain aspects of LOS from ED staff. In particular, hospitalists were inclined to complete their work-ups and CPOE orders in the ED of patients being admitted rather than in inpatient units. Doing so obviously keeps patients in the ED for more time and further increases ED LOS.

On the positive side, the ED played an innovative role in the MMC-NI clinical information system implementation. It provided the first critical physician leadership to the development of online progress notes and physician templates for documentation, which inspired a pioneer attitude amongst the other physicians in the entire hospital and made post-implementation issues with CPOE and workflow more acceptable. ED physicians' acceptance of the system was high with around 85% of ED physician orders being placed directly into the EHR. Service specific order sets and system templates facilitated evidence-based care and adherence to performance indicators, such as CMS core measures applicable to the ED. ED staff commented that access to patient information within the EHR was quick and efficient. The ER event tracking system was particularly popular. Prior to its use, ED clinicians spent a fair amount of time waiting on test results before making decisions. Post-implementation, the ER event tracking system alerted staff when test results were available. This system was credited with expediting care decisions, which translated into decreased patient and clinician wait times, speedier delivery of treatment, and faster patient throughput.

This case study shows that implementing effective EHR, CPOE, and ER event tracking systems within a hospital to communicate relevant information at the point of care requires extensive modification of care processes. Efficiency is often a goal of such system changes. LOS is commonly examined as an outcome indicator of both efficiency and quality. As this case study shows, ED LOS may be confounded by multiple factors, and especially in the short-term, may appear to increase. Thus, focus on ED LOS as a measure of quality and efficiency should be carefully considered – a single metric is unlikely

to reflect the complexity of changes that occur when complex clinical information systems are implemented. The successful implementation of clinical information systems alters the work activities for all staff, but creates opportunities for quality improvement as care processes are modified to take advantage of the technological enhancements.

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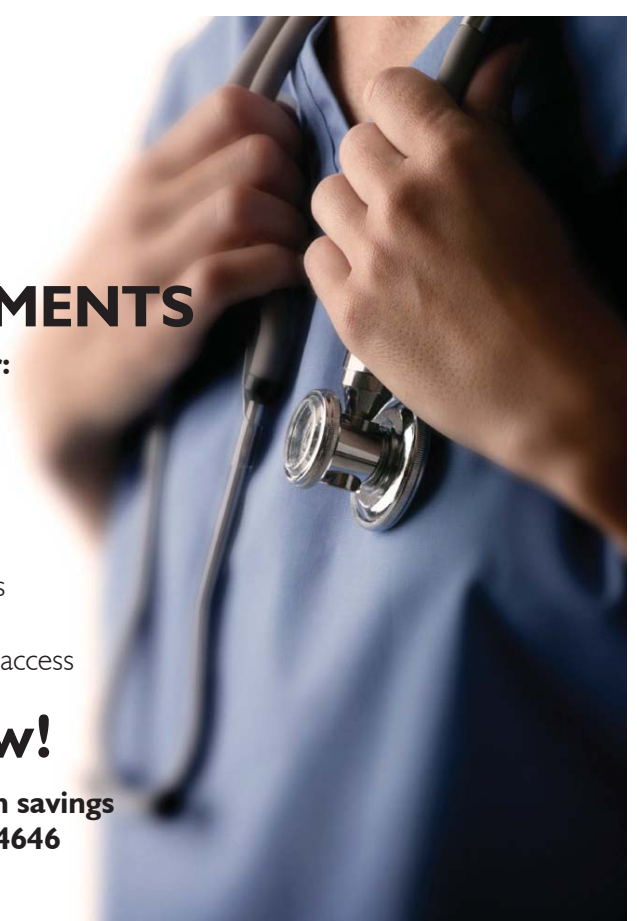
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