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## Can Advanced EMRs Make Patient Care Safer?



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Patient safety is one of the foremost challenges in US healthcare, affecting hundreds of thousands of patients and costing tens of billions of dollars every year. According to the landmark Institute of Medicine (IOM) report "To Err is Human: Building a Safer Health System", 44,000 to 98,000 people die each year in US hospitals from preventable medical errors.

Advanced electronic medical records (EMRs) are widely expected to improve patient safety, but the evidence of advanced EMRs' impact on patient safety is inconclusive. The IOM report and other experts note that existing research on this topic suffers from limited samples (one or few prominent hospitals), weak methodology, and conflicts of interest due to researchers' financial ties to the health IT industry.

A key challenge to evaluating EMRs' impact on safety has been the lack of reliable and comprehensive data. In the current study, the authors overcame this challenge by constructing a panel of Pennsylvania hospitals over 2005–2012 using data from several sources. These data allowed the authors to test the impact of hospitals' adoption of advanced EMRs on patient safety events while controlling for hospital fixed effects, hospital size, and other hospital-level covariates, as well as county-level covariates including population, median household income, and unemployment.

The study offers evidence of substantial improvements in patient safety due to the adoption of advanced EMRs. The results suggest that increased efforts to foster the adoption of advanced EMRs will make the resulting patient safety benefits more universal.

### Health IT, EMRs and Patient Safety

Great Britain House of Commons Health Committee (2009) defines patient safety as "freedom, as far as possible, from harm, or risk of harm, caused by medical management (as opposed to harm caused by the natural course of the patient's original illness or condition)." The publication of "To Err is Human" (IOM 2000) catapulted the patient safety movement into the medical mainstream. The goal of the patient safety movement is to eliminate preventable patient harm through improved systems and to find solutions when harm is traditionally considered unpreventable.

Modern medicine is extremely complex. The sheer number of diagnoses, drugs, and procedures produces cognitive overload that may lead to errors by competent, caring, and conscientious care providers. Although many IT applications play a role in the overall improvement of care quality and patient safety, EMRs play a particularly salient role and thus EMRs are widely studied by multiple disciplines. The current study focuses on advanced EMR applications. Dranove et al. (2014) defined advanced EMR as CPOE (Computerised Provider Order Entry) or PD (Physician Documentation), which are integrated into physician workflows and may also have the most clinical impact.

However, measuring the impact of various interventions (including health IT) on patient safety has been challenging. "... (Current) literature is inconclusive regarding the overall impact of health IT on patient safety" (IOM 2011). Since large-scale data are hard to gather, many of the studies are done at single or few sites at prominent hospitals. Though the medical informatics literature includes systematic reviews of studies performed at few sites, the conclusions of these reviews are not definitive.

Measuring patient safety is another challenge. For example, some studies have measured patient safety outcomes using Patient Safety Indicators (PSIs), which are inferred from billing data using AHRQ algorithms. With select PSIs as outcome measures, Parente and McCullough (2009) find a small beneficial effect of EMR; Freedman, Lin and Prince (2014) find beneficial effects of CPOE; Culler et al. (2007) find no effects or harmful effects of health IT; and Menachemi et al. (2007) find beneficial effects of health IT.

### Data Sources and Methodology

The authors constructed an unbalanced panel for Pennsylvania hospitals over 2005–2012 by collating data from multiple sources: (i) measures for patient safety were sourced from the Pennsylvania Patient Safety Authority (PSA), (ii) measures for adoption of health IT were sourced from the Healthcare Information and Management Systems Society (HIMSS) data set, (iii) hospital-level controls were sourced from the Pennsylvania Health Care Cost Containment Council (PHC4) and the American Hospital Association (AHA survey data), and (iv) location-specific controls were sourced from the Area Health Resources Files (AHRF).

Since mid-2004, Pennsylvania state law has mandated that hospitals report a broad range of patient safety events to the PSA. The authors used an extract of the PSA data set, which includes all events reported from 1 January 2005 to 31 December 2012. For this eight-year period, the data set has 231 unique Pennsylvania hospitals, though the number of hospitals varies by the year. These hospitals reported approximately 1.7 million events over eight calendar years, classifying 214 distinct event types in nine categories.

The five most frequent event categories are: (1) errors in procedure, treatment, or test (error PTT); (2) medication errors; (3) falls; (4) skin

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integrity events; and (5) complication of procedure, treatment, or test. The top two event types — medication errors, and errors related to procedure, treatment, or test — account for more than 700,000 event reports.

For location-specific controls, the researchers used the Federal Information Processing Standards' (FIPS) county code to match records from AHRF to the combined PHC4 and AHA data. They sourced the following county-level variables: (i) population estimate (2002), (ii) percentage of population over 65 (2002), (iii) percentage of population belonging to white race (2002), and (iv) median household income (2000). The researchers did not expect these controls to have a major impact on the estimated effects of EMRs on patient safety.

HIMSS data from the years 2005 to 2012 were used to construct EMR adoption measures. The authors took the hospital's adoption year as the year succeeding the hospital's declaration of "live and operational" status, which ensures time precedence between EMR adoption and patient safety events.

Since the study uses panel data, the authors will use the differences-in-differences (DID) estimator.

## Results and Discussion

The authors specifically looked at three subcategories that produce large number of events and that are expected to be affected by the adoption of advanced EMR, viz., medication errors; error in procedure, treatment, or test; and complications of procedure, treatment, or test. By focusing on subcategories, the authors sought two insights: (i) which subcategories benefit from advanced EMR, and (ii) which subcategories are driving the overall average beneficial effect.

Using the DID identification strategy, the authors found that advanced EMRs led to a 27 percent decline in patient safety events. This overall decline was driven by declines in several important subcategories — 30 percent decline in events due to medication errors and 25 percent decline in events due to complications. The authors also found suggestive evidence of a decline in the most frequent subcategory of events, those due to errors in procedure, treatment, or test.

The results hold against a number of robustness checks, including, but not limited to, falsification test with non-clinical IT and falsification test with a subcategory of events that is not expected to benefit from advanced EMRs.

The effects of advanced EMRs on the subcategories:

- Medical errors - EMRs improve patient safety by alleviating communication issues (legibility, drug name confusion, etc.), shortening transmission time and completion time, enabling "correct" ordering by making it easier to integrate with patient data and Clinical Decision Support System (CDSS). Physician documentation may help provide more information about the patient's indications and progress during the hospital stay.
- Complications of procedure - EMRs may help reduce the risk of complications through direct mechanisms such as with errors of discrepancy between emergency departments' interpretation of X-ray and EKG and final reading, as well as through less obvious mechanisms. For example, EMR may even help when no evidence-based guidelines exist as yet and consensus cannot develop among care providers on the treatment plan.
- Error PTT - For surgeries, advanced EMRs may help with accurate ordering of the right procedure and with correct identification of the patient and site. With radiology and imaging test problems, advanced EMRs may help with correct ordering of the right test, correct identification of the patient, and appropriate scheduling of the test.

The findings should be interesting to both hospital managers and policy makers. Despite financial incentives from the federal government, advanced EMR adoption in the US was 67 percent in 2012. As the study shows, improvement in patient safety is an additional benefit of advanced EMR adoption that non-adopting hospitals should take into account when evaluating IT investments. Further efforts in fostering adoption and meaningful use of EMRs may make the benefits more universal and help in saving patients from the risk of harm in hospitals.

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Published on : Fri, 28 Nov 2014