Diagnosis-Based Clinical Decision Support Improves CHF Quality Measures

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ABSTRACT

Introduction

The implementation of effective clinical decision support (CDS) tools with computerized provider order entry (CPOE) systems provides an opportunity to positively impact patient safety and quality for all hospitalized patients. Taking advantage of this opportunity, however, necessitates identifying areas for improvement, creating usable solutions and tracking progress. At our institution, we identified two National Hospital Quality Measures (NHQM) for heart failure (HF) that were below national average. We implemented two distinct CDS tools to improve our performance. Initially mandatory CDS was added to the discharge process. Subsequently we developed a process for capturing primary and secondary diagnoses in a coded fashion and leveraged it to provide diagnosis-based CDS for HF patients. Compliance with NHQM HF metrics was reassessed after each intervention. The purpose of our study was to determine how our solutions impacted quality.

Statement of design

We compared our compliance with NHQM HF discharge metrics before changing our processes (7/02-8/07), after our mandatory CDS intervention (10/07-8/09) and after implementation of our diagnosis-based CDS (10/09-3/10). The metrics compared were providing HF discharge instructions\(^1\) and ACEI/ARB prescription documentation.\(^2\)

Results

Compliance with NHQM HF discharge metrics improved after implementation of our mandatory CDS for providing HF discharge instructions (56.8% vs 92.1%, \(p<0.0001\)) and for ACEI/ARB prescription documentation (84.3% vs 97.7%, \(p<0.0001\)). Compliance remained at the same level after changing to diagnosis-based CDS for providing HF discharge instructions (92.1% vs 88.7%, \(p=0.18\)) and ACEI/ARB prescription documentation (97.7% vs 97.2%, \(p=0.84\)). Compared with the mandatory CDS, use of diagnosis-based CDS reduced clinician interruptions (3,016 vs 14,301 interruptions for nine months periods post and pre-intervention).

Conclusions

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\(^1\) The HF Discharge Instructions measure (HF-1) monitors whether heart failure patients are discharged home with written instructions or educational material given to patient or caregiver at discharge or during the hospital stay addressing all of the following: activity level, diet, discharge medications, follow-up appointment, weight monitoring, and what to do if symptoms worsen.\(^3\)

\(^2\) The ACEI or ARB for left ventricular systolic dysfunction (LVSD) measure (HF-3) monitors whether heart failure patients with LVSD are prescribed an ACEI or ARB at hospital discharge. For purposes of this measure, LVSD is defined as chart documentation of a left ventricular ejection fraction (LVEF) less than 40% or a narrative description of left ventricular systolic (LVS) function consistent with moderate or severe systolic dysfunction.\(^3\)
We have shown two effective methods for improving quality by positively impacting NHQM HF discharge metrics. We have demonstrated that diagnosis-based CDS interrupts clinicians less frequently than mandatory CDS and is equally effective. This method of CDS may offer usability benefits by tailoring solutions to specific, identified areas for improvement while leaving other aspects of CPOE unaffected.

**INTRODUCTION**

The advent of electronic health records (EHRs) has made possible the widespread adoption of clinical decision support (CDS) tools across many areas of patient care. One area of CDS utilization that has shown particular promise is incorporation of these tools within computerized provider order entry (CPOE) systems. Recent reviews of CDS systems have found hundreds of published implementations.(1,2) Among implementations with sufficient published data, 64% had a positive impact on provider behavior. Features that were associated with success included automated use of CDS, providing recommendations rather than assessments and having CDS embedded at the time and location of decision making. By appropriately implementing CDS, hospital systems may be able to change provider behavior where needed to improve patient care and overall health care quality.

The initial National Hospital Quality Measures (NHQM) were developed by the Joint Commission and the Centers for Medicare and Medicaid Services in 2001.(3) These metrics were devised to support and stimulate substantial improvement in the quality of hospital care. Hospital systems are given financial incentives to report these metrics, which are in turn made available to the public. The initial quality measures were specific to acute myocardial infarction (AMI), congestive heart failure (HF), pneumonia and pregnancy. In the intervening years since publication of these initial quality measures many other areas of patient care have been targeted. Hospitals are encouraged to develop quality improvement initiatives to increase quality in all aspects of care but particularly those in which hospitals are below benchmark standards.

At our institution, we monitor NHQM metrics and develop quality improvement initiatives which target areas in need of improvement. We identified two NHQM metrics for HF that were below the national average, namely providing appropriate instructions on discharge and ensuring that HF patients are prescribed angiotensin-converting enzyme inhibitors (ACEIs) or angiotensin receptor blockers (ARBs) when appropriate. Two distinct CDS tools were implemented within our CPOE to improve our performance on these metrics. In this study, we describe the CDS tools developed and how these solutions impacted quality metrics and physician workflow.

**METHODS**

Study Setting
Massachusetts General Hospital (MGH) is an academic teaching hospital and a founding member of the Partners HealthCare network in Boston, MA. Physicians and other health care providers use an internally developed application known as the Longitudinal Medical Record and an internally developed CPOE to review patient medical records and enter orders, respectively. We obtained anonymous, aggregate data from an administrative database and then analyzed three periods of time: prior to CDS implementation (7/2002 to 08/2007), usage of a mandatory CDS tool (10/2007 to 8/2009) and usage of a diagnosis-based CDS system (10/2009 to 3/2010).

Intervention

A CPOE admission order set specific to HF was modified to prompt providers to order an ACEI or ARB as part of the care plan (Figure 1). On discharge, providers were prompted to evaluate every patient who was on the Medicine service for heart failure and to document that those patients with heart failure received appropriate discharge instructions (Figure 2). This mandatory intervention was introduced in October 2007.

![Figure 1: Example of the CHF admission order set which prompts the provider to order an ACEI or ARB.](image)

![Figure 2: Example of generic discharge orders which prompt for appropriate discharge instructions for CHF patients.](image)

After a trial period of the CDS system described above, the tool was further refined by leveraging a process that captures coded primary and secondary diagnoses. This enabled the provision of diagnosis-based CDS in which HF-
Specific prompts are given only for those patients who have a diagnosis of HF. We defined HF as having a primary or secondary diagnosis of Congestive Heart Failure, Cardiomyopathy, or Pulmonary Edema. In addition, if a patient is diagnosed with Atrial Fibrillation, the discharging provider is required to answer whether the patient shows signs or symptoms of Heart Failure. This modification was intended to reduce clinician workflow interruptions and was implemented in September 2009. Clinician interruptions were tallied in the nine months preceding and following adoption of diagnosis-based CDS.

Statistical Analysis

The primary outcome was compliance with ACEI/ARB prescription and documentation of providing HF discharge instructions. The secondary outcome was the difference in clinician workflow interruptions. Two-tailed unpaired t-tests were performed to assess studied differences. Multiple comparisons were accounted for using the Bonferroni method, which resulted in a statistical significance threshold of $p<0.0125$.

RESULTS

Mandatory CDS Implementation

Our baseline compliance with providing HF discharge instructions was 56.8% (7/2002 to 8/2007). After our implementation of mandatory CDS, our compliance improved to 92.1% (10/2007 to 8/2009) which was statistically significant ($p<0.0001$). Baseline compliance with ACEI/ARB prescription was 84.3% for the same study period, which improved significantly to 97.7% after implementation of mandatory CDS ($p<0.0001$).

Diagnosis-Based CDS Implementation

Analysis of compliance with providing HF discharge instructions after implementation of diagnosis-based CDS demonstrated a compliance rate of 88.7%, which was statistically insignificant (92.1% vs 88.7%; $p=0.18$). Similarly, analysis of ACEI/ARB prescription revealed a compliance rate of 97.2%, which was likewise statistically insignificant (97.2% vs 97.7%; $p=0.84$).

Clinician Workflow Interruptions

In the nine months preceding adoption of the diagnosis-based CDS, clinician workflow was interrupted a total of 14,301 times due to our CDS tool. In the nine months after its adoption, clinician workflow interruptions from the revised tool dropped to 3,016.

DISCUSSION
In this study we have demonstrated a long-term improvement in two NHQM HF quality measures by implementation of a CPOE CDS tool that targets a specific area in need of improvement. Further, we have shown that it is possible to maintain these improvements while honing CDS tools to minimize disruption of clinician workflow. By careful analysis of existing quality measures, it is feasible to design and execute a successful quality improvement initiative via CPOE CDS systems.

While this is the first study that we are aware of that specifically addresses the use of CDS interventions to improve NHQM HF quality measures, there have been published studies of CDS interventions aimed at improving other quality measures. A computerized, email-based pharmacist alert system aimed at improving adherence to clinical practice guidelines relating to AMI, for instance, was shown to improve adherence to secondary prevention guidelines in coronary heart disease. Similarly, a CPOE CDS tool targeted towards suspected AMI showed improvements in compliance with recommended treatment regimens. These improvements in AMI quality measures by adherence to accepted guidelines, if broadly adopted, may have a profound impact on patient care. One study suggested that the outcome difference that would be gained by eliminating the gap between actual and ideal clinical practice would be significantly greater than that of a novel treatment that reduced AMI mortality by 30%. By developing, testing and refining CDS tools such as those described in this study, we are taking important steps towards removing that gap.

In order to narrow the gap between present practice and complete adherence to quality metrics, it is important to look carefully at the cases where quality metrics are missed. Our research group, for instance, has published predictors of non-adherence to NHQM metrics for both HF and pneumonia. That study looked at HF admissions between July 2004 and June 2008--a time interval which partially overlaps with the current study--and found that patients admitted to non-cardiac floors were less likely to receive HF discharge instructions. Additionally, patients with renal failure were found to receive fewer ACEI/ARB prescriptions. These gaps are clinically intuitive. Renal failure is a relative contraindication to ACEI/ARB usage; that quality measure differential was due in part to lack of appropriate documentation of reasons to not prescribe. Providers working on cardiac floors would be most experienced with discharging cardiac patients, and thus more likely to always provide appropriate discharge instructions. Furthermore, general Medicine patients often have multiple conditions, complicating the education process. Understanding where these gaps in care tend to lie will help guide further quality improvements.

Challenges also exist in accurately measuring adherence to quality metrics. CDS tools rely on clinical diagnoses, while NHQM metrics are tied to billing diagnoses. When these diagnoses diverge, CDS may not trigger appropriately. Additionally, while the increasing prevalence of EHRs would suggest that this task is becoming easier, further inquiry makes it clear that it is easy to get the details wrong. A study looking at surgical colorectal cancer quality metrics in the Veterans Affairs hospitals compared administrative data abstracted remotely from an EHR against data from local chart abstraction. Quality metrics were significantly worse when abstracted
automatically from administrative data, in part due to procedural miscoding. Highlighting similar difficulties, a study examining outpatient quality metrics for coronary artery disease found a large discrepancy between metrics automatically extracted from an EHR and manual review of the same records. A significant number of quality failures were due to misclassification from the automated system and failure to appropriately process free text entries. Both of these studies strike a cautionary note regarding the care that must be taken in creating mechanisms to assess quality.

**CONCLUSION**

Despite the technical difficulties inherent in defining and measuring quality in health care, it is clear that these metrics are here to stay and will likely play an increasingly important role in how hospitals are reimbursed by payers and how hospitals are perceived by the public. The adoption of EHRs and specifically CPOE systems create the opportunity to improve these quality measurements but necessitate identifying areas for improvement, creating usable solutions and tracking progress. This study has demonstrated the effective implementation and refinement of CDS tools to improve quality measurements in HF.

**REFERENCES**


AUTHOR BIOGRAPHIES

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Dr. Wanderer is a senior resident in anesthesiology at Massachusetts General Hospital. He graduated summa cum laude from the University of Pennsylvania with degrees in biology and in computer science, obtained a research master’s degree at the University of Cambridge applying advanced data processing tools in biological research and returned to the University of Pennsylvania for medical school where he worked on clinical data presentation systems. At MGH, he has performed research using peri-operative data, created a system for peri-operative schedule assignments and worked with the quality and safety team in evaluating the impact of CPOE clinical decision support tools.

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Yanie is a Senior Consultant at MGH’s Center for Quality and Safety, where she has focused on improving the discharge process and reducing readmissions. Yanie has worked in consulting for Deloitte Consulting and in finance for Bank of America Securities. Yanie has a MHS degree from the Bloomberg School of Public Health at Johns Hopkins University and a BS in Business Administration from the University of California at Berkeley.

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Dr. Karson is Director of the Clinical Decision Support Unit in the MGH Center for Quality and Safety. He is also an academic hospitalist in the MGH Department of Medicine. He graduated summa cum laude from Dartmouth College with a degree in mathematics and obtained his MD and MPH at Harvard. He has worked extensively in developing, supporting and analyzing decision support tools in order to improve the quality, safety, and efficiency of medical care.