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The Use of Decision Support to Measure Adherence to a National Imaging Quality Measure

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Abstract

Rationale and Objectives—Current methods for measuring adherence to national imaging quality measures often requires resource-intensive chart review. Computerized decision support systems may allow for automated capture of these data. We sought to determine the feasibility of measuring adherence to a national quality measure regarding CT pulmonary angiograms for pulmonary embolism (PE) using measure-targeted clinical decision support, as well as whether the associated increased burden of data capture required by this system would affect the use and yield of CTs.

Materials and Methods—This IRB-approved prospective cohort study enrolled patients from 9/1/09 to 11/30/11 in the emergency department of a 776-bed quaternary care adult-only academic medical center. Our intervention consisted of a national quality measure-targeted clinical decision support tool for CT pulmonary angiograms, which required mandatory input of the Wells criteria and serum D-dimer level. The primary outcome was the documented adherence to the quality measure prior and subsequent to the intervention, and the secondary outcomes were the use and yield of CT pulmonary angiograms.

Results—A total of 1,209 patients with suspected PE (2.0% of 58,795 ED visits) were imaged by CTPA during the 12-month control period, and 1,212 patients were imaged in the 12 months

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All authors had access to the data and a role in writing the manuscript

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following the quarter during which the intervention was implemented (2.0% of 59,478 ED visits, p=0.84). Documented baseline adherence to the national quality measure was 56.9% based upon structured review of the provider note. After implementation, documented adherence increased to 75.6% (p<0.01). CT pulmonary angiogram yield remained unchanged, and was 10.4% during the control period and 10.1% after the intervention (p=0.88).

Discussion—Implementation of a clinical decision support tool significantly improved documented adherence to a national quality measure, enabling automated measurement of provider adherence to evidence without the need for resource-intensive chart review. It did not adversely affect the use or yield of CT pulmonary angiograms.

Keywords

Quality Measures; Computerized Decision Support; Imaging; Emergency Department

Introduction

Current healthcare reform initiatives focus on increasing value, improving quality and reducing waste, often through the use of publicly reported national quality measures (NQMs).(1–3) Much of this activity has been directed towards the utilization of high-cost imaging like computed tomography (CT), whose use has increased significantly over the past two decades.(4,5) While CT is useful because of its diagnostic speed and accuracy, (6) it has come under scrutiny because of its potential for inappropriate use, especially in the emergency department (ED),(7,8) as well as its potential risks of radiation exposure and contrast-induced nephropathy.(9,10)

One area of intense focus is the ED use of CT for patients with suspected pulmonary embolism (PE). Although validated, evidence-based decision tools designed to help clinicians identify which patients need imaging have been available for over 12 years, (11) and are now endorsed by multiple specialty societies, (7,12,13) inappropriate use continues and educational interventions have not been shown to improve appropriateness.(8,14–19) An evidence-based NQM was recently endorsed by the National Quality Forum(20) but, in a recent study, one-third of CT pulmonary angiograms (CTPAs) performed in ED patients with suspected PE did not adhere to it.(16) Another recent study demonstrated that pretest probabilities are rarely documented by emergency physicians prior to obtaining CTPAs.(21) Additionally, a number of public comments regarding the NQM cited concerns regarding the level of intensive manual chart review that would be necessary to gather the granular data required to determine whether or not CTPAs were adherent to evidence.(20)

Computerized physician order entry (CPOE) systems with integrated clinical decision support (CDS) have been suggested as a method for improving overall quality of care(22,23) and their use has been mandated by the Health Information Technology for Economic and Clinical Health (HITECH) Act and federal meaningful use regulations.(24,25) While the use of electronic health records (EHRs) to collect data for quality measures has been discussed, CDS has not yet been used to measure adherence to NQMs.(26)

An earlier study demonstrated that the implementation of CDS at our institution was associated with a decrease in the use, and an increase in the yield, of CTPAs in the ED.(27) However, this first-generation CDS did not allow capture of the granular data necessary to measure the adherence to evidence described in the NQM for each CTPA order. We subsequently developed an NQM-targeted CDS tool, which was based on the same evidence-based recommendations as the first-generation CDS but designed to streamline this data capture. However, this NQM-targeted CDS required an increased number of provider mouse clicks to enter data, and it was unknown whether this would lead to provider reluctance to order CTPAs and deleterious effects on both their use and yield. Therefore, in this study, we sought to determine the feasibility of using an NQM-targeted CDS tool to measure CTPA orders' adherence to an evidence-based NQM, and also whether the associated increased burden of data capture would affect the use and yield of CTPAs.

Materials and Methods

Study Design and Setting

The study was performed in a 776-bed quaternary care, adult-only academic medical center with an annual ED volume of approximately 60,000 patients. A Level 1 Trauma and Burn Center, the ED hosts an emergency medicine residency and all attending emergency physicians are Board eligible/certified. Institutional review board approval with a waiver of informed consent was obtained for this HIPAA-compliant, prospective controlled study, conducted from September 1, 2009 to November 30, 2011.

Study Participants

The study population included all patients who presented to the ED and received a CTPA during the 12-month periods prior (control) and subsequent (intervention) to the quarter during which an NQM-targeted CDS was implemented (Sept.–Nov. 2010).

Intervention

Prior to the study, all imaging orders were placed via a CPOE system (Percipio, Medicalis Corporation, San Francisco, CA), by a licensed provider.(28) A first-generation CDS, implemented in late 2007, had asked the clinician to enter only their clinical suspicion for PE (high, medium, or low) and the serum D-dimer level (elevated, normal, or not done), and required three provider mouse clicks to complete the CTPA order (Figure 1).(27,29) This study's intervention consisted of the implementation of an NQM-targeted CDS tool for CTPA within the CPOE system. Like the first-generation CDS, the evidence base for the NQM-targeted CDS was the Wells criteria.(11) However, the NQM-targeted CDS required mandatory data input (a discrete 'yes' or 'no' response) for each unique clinical attribute of the Wells criteria for the patient being imaged (clinical signs and symptoms of deep vein thrombosis [DVT], PE as the leading diagnosis, heart rate > 100 beats per minute, immobilization at least three days or surgery in the previous four weeks, previous PE or DVT, hemoptysis, and malignancy with treatment within the past six months) as well as the serum D-dimer level (normal, elevated, not ordered, or not yet known), and required a total of nine provider mouse clicks for completion of each CTPA order (Figure 2). Together,

these granular Wells criteria data and the D-dimer data were combined to determine whether CTPA imaging for the patient being evaluated was adherent to evidence.

NQM-adherent imaging orders received no further intervention. Those CTPA orders that were non-adherent received specific CDS messages tailored to the reasons for non-adherence and based on the NQM evidence-base. Providers entering CTPA orders for patients with low pretest probabilities for PE who had not had a D-dimer ordered (or who had a D-dimer ordered for which results were not yet known) received the message “Based on the information you have provided, a CT may not be appropriate for your patient. Published guidelines suggest that a patient with a low clinical probability of PE should have a D-dimer measured to further guide decision-making. A negative D-dimer result, in combination with your patient’s risk via the Wells Criteria, may safely exclude PE.” Those in whom a serum D-dimer level was normal (and thus were not appropriate for CTPA via the NQM) received the message “Based on the information you have provided, a CT may not be appropriate for your patient. Published guidelines suggest that a patient with a low clinical probability of PE and a normal D-dimer is unlikely to have a pulmonary embolism.” Imaging orders for patients with elevated D-dimer levels were considered adherent to evidence and no advice was given. At each step of the process, the ordering clinician could either cancel the order or ignore the CDS advice and proceed with the CTPA order.

Sample Size

We collected a random sample of CTPA orders from both the control and intervention periods in order to compare adherence to the NQM. This sample size was powered to detect a 15% effect size with a power of 0.8 (alpha=0.05). We assumed a baseline adherence of 70%, which resulted in a desired sample size of 320 records (160 in each group).

Data Collection

Adherence to the NQM was calculated for each CTPA in both the control and intervention cohorts. Adherence was determined by chart review (similar to that required to measure compliance with current NQF NQMs) during the control period and by both chart review and review of data entered into the NQM-targeted CDS during the intervention period. The chart reviews were conducted by attending staff physicians (two emergency physicians and one internist). In addition, all completed CTPA reports from both study periods were reviewed for presence of PE, using a computerized algorithm incorporating Natural Language Processing (NLP) techniques based on the GATE (General Architecture for Text Engineering) framework. The engine recognizes negation and nuances in the phrases within the radiology report to determine whether the diagnosis of PE was described as being present or absent. The engine has been previously validated, showing accuracy of 97.8% when compared to manual review(27).

Statistical Analyses

The primary outcome measure was documented adherence to the NQM. The secondary outcomes were the utilization rate of CTPA (based upon the number of completed CTPAs per registered number of ED patient visits) and the yield of CTPA, defined as the proportion of all CTPAs performed during both study periods that were determined to be positive for

PE by the NLP algorithm. Analyses were performed using Microsoft Excel 2008 (Microsoft, Redmond, WA) and JMP Pro 10 (SAS Institute, Cary, NC). Chi-square tests with proportional analyses were used to assess differences between the control and intervention groups. A two-tailed p-value of <0.05 was defined as statistically significant.

Results

After NQM-targeted CDS implementation, documented adherence to evidence increased, while use and yield of CTPA remained unchanged. A total of 1,209 patients with suspected PE (2.0% of 58,795 ED visits) were imaged by CTPA during the 12 month control period (9/1/09–8/31/10), and 1,212 patients were imaged in the 12 months following the quarter during which the intervention was implemented (12/1/10–11/30/11, 2.0% of 59,478 ED visits, p=0.84). There were no differences in either age (56.0 vs. 55.1 years, p=0.81) or gender (451/1209 [36.7%] male vs. 466/1212 [38.4%], p=0.70) between the patients undergoing CTPA in the control and intervention groups

Documented adherence to the NQM for use of CTPA in the ED during the control period was 56.9% based upon structured review of the provider visit note in the ED electronic record. After implementing NQM-targeted CDS, documented adherence increased to 75.6% (p<0.01). CTPA yield subsequent to the NQM-targeted CDS implementation remained unchanged, and was 10.4% during the control period and 10.1% after the intervention (p=0.88) (Table). A comparison of the clinical data captured in the NQM-targeted CDS to that contained within the provider note during the intervention period found that 82% were concordant (clinical data entered into the NQM-targeted CDS matched data documented in the emergency department provider note), 3% were discordant (clinical data captured in NQM-targeted CDS conflicted with data entered in the provider note), and 15% of provider notes did not contain some of the clinical data entered into the NQM-targeted CDS (thus categorized as incomplete documentation in the provider note).

Discussion

An NQM-targeted imaging CDS enabled the granular clinical data collection needed to streamline the measurement and automate monitoring of ED provider adherence to evidence encapsulated in the CTPA NQM, thus obviating the need for resource intensive retrospective chart reviews. Documented adherence to NQM increased nearly 20%; from 57% to 76% post CDS implementation.

To our knowledge, this is the first example of a CDS tool specifically designed to mirror an imaging NQM. A meta-analysis of the effectiveness of CDS on provider performance found that 64% of CDS interventions studied demonstrated improvements in practice.(30) Similarly, another recent study of the use of CDS in imaging also demonstrated a reduction in inappropriate imaging use (31). However, neither this study nor any of the studies cited in the meta-analysis studied CDS tools targeted towards imaging NQMs.

This increase in documented adherence to evidence with NQM-targeted CDS – without a detectable change in use and yield of CTPAs - suggests that the change may only reflect improved documentation rather than a measurable improvement in appropriateness of CTPA

use. However, it is notable that the increased workflow burden (the additional number of mouse clicks required to submit a CTPA order with NQM-targeted CDS compared to the first-generation CDS) that enabled automation of monitoring of ED provider adherence to the CTPA NQM did not adversely affect the gains made in the use and yield of CTPA by the first-generation CDS (which had decreased use of CTPAs in ED patients by 20% while increasing the yield from 5.8% to 9.8%).(27,29) Given that the same evidence base (the Wells criteria) was used in both CDS tools, we did not expect to see an interval improvement in use or yield, but we were reassured that we did not find any regression due to the increased workflow burden.

It is also reassuring that only 3% of the data captured during the implementation of the NQM-targeted CDS was discordant when compared to the provider note. This indicates that the data upon which the CDS was basing its appropriateness recommendations accurately reflected the patient's clinical presentation. The discordant data may have been due to the fact that provider notes and imaging orders are often entered by different individuals in our academic ED, which is typically staffed by residents and physician assistants who report to emergency medicine attending physicians. Indeed, only a very small portion of clinical data entered into the NQM-targeted CDS (a portion of the discordant data; <3%) could have been potentially entered to falsely improve a provider's adherence to NQM.

While there was significant concordance between the provider note and the CDS-captured data during the intervention period, 15% of the data required to document adherence to the NQM was missing from the provider note. This may further indicate that a benefit of NQM-targeted CDS is that it prompts the documentation of reasons why providers are obtaining imaging that is already guideline-adherent. However, if the CTPAs being ordered were indeed appropriate, then facilitating their categorization as such may be worthwhile to help design and target further quality improvement initiatives. Additionally, the more comprehensive documentation of relevant clinical information in radiology order entry with NQM-targeted CDS will improve the communication of key clinical data between providers (emergency physicians and radiologists) which, in turn, may help improve the quality of the radiologists' interpretations.

Our study has a number of limitations. It was performed at a single academic institution with more than 5 years of experience with imaging CDS,(28) and thus our results may not be generalizable. However, a number of commercial vendors have begun to implement imaging CDS with their electronic medical record offerings and, with the incorporation of CDS into meaningful use requirements, imaging CDS tools are becoming more widely available. In addition, we were unable to confirm the accuracy of clinical data documented in the electronic medical record, as we did not interview or examine patients directly. We may have missed cases of inaccurate provider documentation of appropriateness, but this is a limitation inherent to the evaluation of any quality measures that are dependent on retrospective chart review.

It is important to note that our results also demonstrate that provision of real-time CDS alone, even when based on high quality evidence, may not optimize appropriate use of CTPA in the ED. Even after implementation of NQM-targeted CDS, nearly 1 in 4 CTPA

orders deviated from the evidence. Prior studies have similarly demonstrated that CDS alone cannot ensure guideline compliance (32,33), although some of these potentially inappropriate orders may have been appropriate and simply a result of the fact that evidence-based guidelines cannot address every clinical scenario. Nevertheless many of these remaining orders were likely not appropriate and additional quality improvement interventions may be necessary to further decrease this potential gap in practice.

In conclusion, NQM targeted CDS is feasible as a method of performing automated measurements and its use is associated with a significant increase in documentation adherence to the NQM..

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Figure 1.
First Generation Clinical Decision Support

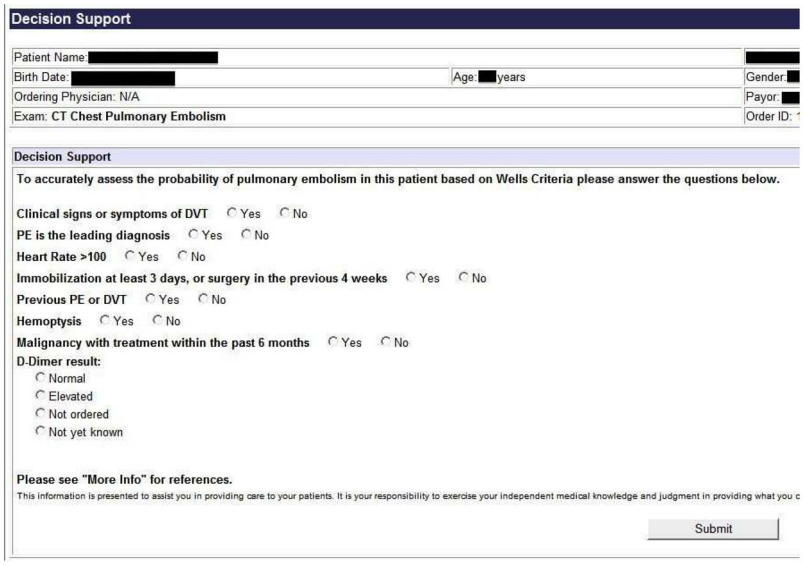

Figure 2.
National Quality Measure-Targeted Clinical Decision Support

Table

Comparison of Control and Intervention Patient Cohorts

	Control Period	Intervention Period	p-value
Age in years (SD)	56.0 (16.9)	55.1 (17.0)	0.81
Male	36.7%	38.4%	0.70
Use of CTPA (% of all ED visits)	2.1%	2.0%	0.84
NQM Adherence	56.9%	75.6%	**<0.01**
CTPA Yield	10.4%	10.1%	0.88

SD=Standard deviation, CTPA=computed tomography pulmonary angiography, ED=Emergency Department, NQM=National quality measure