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Refining Clinician Workflow as a Means to Improving Catheter Quality Measures

Martina A. Clarke[1,2] Jana L. Wardian[3] Brandon S. Fleharty[4] Craig G. Reha[5] Justin R. Birge[3]

[1] School of Interdisciplinary Informatics, University of Nebraska–Omaha, Omaha, Nebraska, United States
[2] Division of Cardiovascular Medicine, Department of Internal Medicine, University of Nebraska Medical Center, Omaha, Nebraska, United States
[3] Division of General Medicine, Department of Internal Medicine, University of Nebraska Medical Center, Omaha, Nebraska, United States
[4] Enterprise Clinical Applications, Nebraska Medicine, Omaha, Nebraska, United States
[5] Enterprise Practice Support, Nebraska Medicine, Omaha, Nebraska, United States

Address for correspondence Justin R. Birge, MD, Internal Medicine Division of General Medicine, 986435 Nebraska Medical Center, Omaha, NE 68198-6435, United States (e-mail: justin.birge@unmc.edu).

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Abstract

Objective This study aimed to improve the quality measure performance for indwelling urinary catheter (IUC) duration, central venous catheter (CVC) duration, and telemetry duration by redesigning clinical decision support (CDS) tools within the documentation process and order workflow.

Methods The effectiveness of the redesign was evaluated using system standard quality reporting methodology to observe device duration, central-line-associated bloodstream infection (CLABSI) rate, and catheter-associated urinary tract infection (CAUTI) rate preintervention (FY2017) and postintervention (FY2018). Electronic health record (EHR) reporting tools were used to evaluate CDS alert data both preintervention and postintervention.

Results Total device duration and line days per patient days were reduced for CVC (12.8% [0.305–0.266]) and IUC (4.68% [0.171–0.163]). Mean telemetry duration was reduced by 16.94% (3.72–3.09 days), and CDS alert volume decreased 18.6% from a preintervention mean of 1.18 alerts per patient per day (81,190 total alerts) to a postintervention mean of 0.96 alerts per patient per day (61,899 total alerts). Both CLABSI (2.8% [1.07–1.04]) and CAUTI (8.1% [1.61–1.48]) rates were reduced, resulting in approximately $926,000 in savings.

Conclusion In this novel model, the redesigned CDS tools improved clinician response to CDS alerts, prompting providers to take action on relevant orders that automatically updated the clinical documentation to reflect their actions. The study demonstrated that effective redesign of CDS tools within the documentation process and order workflow can reduce device duration, improve patient outcomes, and decrease CDS alert volume.

Keywords
- clinical decision support
- alert fatigue
- electronic health record
- quality improvement

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Introduction

Problem Description

Previous system initiatives centered on education and awareness resulted in some improvement in outcomes related to the indwelling urinary catheter (IUC), central venous catheter (CVC), and telemetry duration domains. Because it did not involve workflow engineering or improvements to make the simple choice the preferred one, the prior solution was insufficient to satisfy system goals.

Available Knowledge

At least 96% of hospitals utilize electronic health records (EHR).[1] When used wisely, clinical decision support (CDS) can provide evidence-based practices and improve patient care by boosting safety measures, improving quality of treatment, and lowering costs.[2] EHR-embedded CDS tools have previously demonstrated improved patient care and outcomes for infections by safely reducing IUC duration in the intensive care unit (ICU),[3,4] and reducing central-line-associated bloodstream infection (CLABSI) and mortality in the surgical intensive care.[5]

Understanding clinician information demands is critical for developing useful EHRs.[6,7] When CDS systems are properly designed, they drive best practices and improve clinical workflow.[8] It is critical to employ alerts with caution as too many alerts might cause alert fatigue (disregarding EHR messages) and impede the implementation of quality treatment.[5,8,9] The use of carefully curated relevant information, built into the documentation workflow, allows providers to prioritize care and readdress current patient treatment needs.[10,11]

Rationale

The rationale for this project centers on the improvement of quality outcomes related to the domains of IUC, CVC, and telemetry device duration. We report on the redesign of CDS tools as a method of achieving additional quality improvement. By integrating CDS into documentation and order workflows, we sought to improve the appropriateness of the information at a time when the clinician was prepared to act.

Specific Aims

The objectives of this project include effective redesign of CDS tools within documentation and order workflows to reach the hospital system's specific goals of reducing device duration, improving patient outcomes, and reducing clinician CDS alert volume by the following:

- Decreasing CVC, IUC, and telemetry duration measured in line days per patient days, total line days, and mean telemetry duration (days) per patient.
- Decreasing observed rate of CLABSI and catheter-associated urinary tract infection (CAUTI).
- Reducing cost through observed reductions in CLABSI rate, CAUTI rate, and telemetry duration.
- Decreasing CDS alert count and improving CDS alert response rate in addition to CVC, IUC, and telemetry.

Methods

Context

Prior to the reported implementation, previous system efforts lowered CVC time by 3%, IUC duration by 29%, and telemetry duration by 13.6%. CLABSI and CAUTI rates were similarly reduced; however, neither had met system-specific goals of 10%. A CDS redesign intervention could result in even more improvements. EHR workflows were deemed to be an area of additional possibility for development based on a physician CDS alert response rate of 10%. Existing CDS was examined with clinical involvement to identify compliance constraints (►Table 1). This review detected subtle flaws in CDS rules and discovered that the timeliness of warnings was frequently insufficient for clinician intervention. To address these challenges, a revised CDS tool was created to boost clinician CDS response rate. This project's population includes all hospitalized patients, not just ICU patients.

Organizational Setting

The Nebraska Medical Center is a quaternary academic trauma and medical center consisting of two hospitals, with a total of 809 beds. In FY2017, we cared for 34,173 hospital admissions and a total of 188,234 patient days (mean duration of 5.51 days). In FY2018, we cared for 34,855 hospital admissions and a total of 197,589 patient days (mean duration of 5.67 days). Nebraska Medicine has a fully integrated EHR.[12]

Intervention

The quality improvement metrics followed prior to the quality metric checklist (QMC) implementation are identical to those followed after the QMC implementation. The QMC implementation did not change quality data reporting or

Table 1 Stakeholders involved in the project

Stakeholder	Role
Chief quality officer	Project lead
Health system quality departments	Operational owners of the quality measures, the definitions of the measures, the specific goals of the health system, the continued following of performance
Clinical stakeholders: intensive care doctors, hospital medicine doctors, surgeons, nurses, advanced practice providers (APPs)	Validation of the workflow and validation of the rules
Steering team: individuals with clinical interests from the clinical stakeholder group	Verify that the proposed clinical decision support (CDS) tool was relevant and that the workflows were appropriately efficient and provided more benefit than the previous workflow

Table 2 Quality improvement measures

Quality measures	
Total CVC duration (d)	The number of days from CVC line insertion until CVC line removal[32]
CVC (line) days per patient days	Calculated by dividing the number of central line days by the number of patient days[33]
CLABSI rate (per 1,000 patient days)	Calculated per 1,000 central line days by dividing the number of CLABSIs by the number of central line days and multiplying the result by 1,000[34]
CLABSI attributable cost (estimated $46,000 per case)	The cost per CLABSI case that could be avoided, on average, if CLASBSI was prevented[35]
Total indwelling urinary catheter (IUC) duration (d)	The number of days from IUC line insertion until IUC line removal
IUC (line) days per patient days	Calculated by dividing the number of urinary catheter days by the number of patient days[26]
CAUTI rate (per 1,000 patient days)	Calculated by dividing the number of CAUTIs by the number of catheter days and multiplying the result by 1,000[26]
CAUTI attributable cost (estimated $10,822 per case)	The cost per CAUTI case that could be avoided, on average, if CAUTI was prevented[35]
Mean telemetry duration per patient (d)	The number of patients with telemetry monitoring divided by the number of patient days[36]
Telemetry cost (estimated $40 per patient per day)[a]	The average daily cost for each patient receiving telemetry
CDS measures collected from the EHR	
Total alert count	The number of alerts presented to providers in the EHR
Alert count per patient per day	Ratio of total alerts divided by the number of patients on whom alerts are fired per day[37]
Alert response rate	How often the provider responded to the alert (% action taken/response rate)

Abbreviations: CAUTI, catheter-associated urinary tract infection; CDS, clinical decision support; CLABSI, central-line-associated bloodstream infection; CVC, central venous catheter; EHR, electronic health record.
[a]There is not an itemized daily cost for telemetry resources. To create an approximate cost-savings measure, we estimated the device cost and technician cost per patient per day.

methodology. Observation of system quality data was not affected by the QMC implementation. The QMC implementation only sought to provide a better decision support tool to increase adherence to institutional clinical standards for need assessment and documentation.

The QMC EHR activity is the CDS intervention (►Table 2). It is a location in the EHR that a clinician can access through an alert informing the clinician that they have a deficiency of over 24 hours related to one of the outlined quality measures. There is a hyperlink in many of the health system's inpatient documentation templates that allows the clinician to launch the activity side by side with the clinician's documentation. For example, if there is a catheter that needs an updated indication or a telemetry order that could be discontinued, there would be a note in the clinician's visit note informing the clinician that these outstanding items need attention. The hyperlink allows the clinician to review the documentation, address the orders, and then the documentation in the clinician's visit note is automatically updated based on the actions that were taken in the QMC. A list of additional definitions can be found in ►Table 3.

Reducing CDS Alerts

Existing CDS rules were evaluated and updated to ensure accuracy and clinical relevance. CDS trigger actions were updated to be noninvasive and built into existing documentation and order workflows. Only a single interruptive alert was retained, which triggered once for all domains (IUC, CVC, telemetry, etc.) and only after a deficiency had persisted for 24 hours and was considered "overdue." This allowed time for clinicians to take the correct action before triggering an interruptive alert and consolidated multiple historical interruptive alerts in each domain to a single "overdue" alert for all domains. The QMC EHR activity was developed to contain all domain-specific CDS alerts and their relevant actions (►Fig. 1). Within the activity, any active deficiency alert was visible and actionable without the need to trigger an invasive alert. This activity provided a framework for providers to review the checklist within their workflow rather than broad, invasive CDS alert triggering. While all CDS alerts were still technically "triggered" by entering the patient chart, the sole remaining interruptive alert was used to guide providers to the QMC activity only when a domain-specific alert was "overdue." Instead of addressing multiple best practice advisories (BPAs), they were put in one place. This allows providers more of an opportunity to address the alert for the patient within the next 24 hours. This intervention simplified their workflow.

Enhancing Documentation

Clinical note writing is separate from CDS, but clinicians are typically taking time to review the overall care of the patient

Table 3 Definition of terms

Term	Definition
Cardiac monitoring (telemetry)	"Continuous cardiac monitoring of hospitalized patients with acute coronary syndromes, titrate anti-arrhythmic medications, and determine the corrected QT-interval (QTc)"[20]
Catheter-associated urinary tract infection (CAUTI)	"A urinary tract infection (UTI) is an infection involving any part of the urinary system, including urethra, bladder, ureters, and kidney. The most important risk factor for developing a catheter-associated UTI (CAUTI) is prolonged use of the urinary catheter"[21]
Central-line-associated bloodstream infection (CLABSI) rate	"The number of CLAB infections per 1000 central line-days"[22]
Central line days	"The total number of days a central line is in place for each patient in the intensive care unit (ICU). The count is performed each day, and each patient with a central line is counted as a central line-day"[22]
Central venous catheter (CVC)	"A device used to draw blood and give treatments, including intravenous fluids, drugs, or blood transfusions"[23]
CLABSI	"A laboratory-confirmed bloodstream infection not related to an infection at another site that develops within 48 hours of central line placement. Most cases are preventable with proper aseptic techniques, surveillance, and management strategies"[24]
Clinical decision support (CDS)	"Provides clinicians, staff, patients or other individuals with knowledge and person-specific information, intelligently filtered or presented at appropriate times, to enhance health and health care"[25]
Indwelling urinary catheter (IUC)	"A drainage tube that is inserted into the urinary bladder through the urethra, is left in place, and is connected to a drainage bag (including leg bags)"[26]
Nonviolent restraints	"A restraint applied as a protective intervention to support medical or surgical care and healing. In such cases protective interventions may be necessary"[27]
Patient days	"A count of the number of patients in a patient care location during a defined time period"[28]
Quality metric checklist (QMC)	"A CDS tool that highlights hospitalized patients who are at risk for a catheter-associated urinary tract infection (CAUTI), a central-line-associated blood stream infection (CLABSI), venous thromboembolism (VTE) or have orders for telemetry or non-violent restraints"[29]
Venous thromboembolism (VTE)	"Refers to a blood clot that starts in a vein. A blood clot that occurs as a result of hospitalization, surgery, or other healthcare treatment or procedure is called healthcare-associated venous thromboembolism (HA-VTE)"[30,31]

and primed to address deficiencies. Standard electronic note templates were updated to reflect the status of the QMC, including the documentation of each domain (e.g., "Telemetry indication: cardiac arrhythmia") or any noted deficiencies. If deficiencies were present, the note-based enhancement prompted the provider before signing the visit note and offered a direct link to the QMC activity (►**Fig. 2**). The purpose of this integration was to provide CDS when physicians were most interested in the status of the relevant items and ready to act. By integrating the QMC to the note, domain-specific CDS management provided efficient, accurate, and relevant note documentation that most physicians were already producing or editing manually (►**Fig. 3**). Most providers adopted this workflow because it was more efficient and accurate.

Implementation

The redesigned CDS and workflow integration was implemented in our EHR at the start of FY2018 (►**Fig. 4**). The implementation process was over a year long with multiple stakeholders involved. The process began with an assessment of the value based on quality performance. The project scope was determined followed by technical development of the QMC activity and health system governance approval. Physicians, residents, and other providers were educated on the purpose and use of the QMC. There were initial break fixes and enhancements to the QMC along with post go live management of the QMC to ensure it was working successfully. The go live date was July 10, 2017, 7 months after project initiation.

Study of the Intervention(s)

There was no randomization or control group used in this observation. Clinical teams caring for all hospitalized patients were educated on the changes and optimal workflows, but adoption was not required. We compared overall system performance in FY2017 (preimplementation) to FY2018 (postimplementation) for each of the below

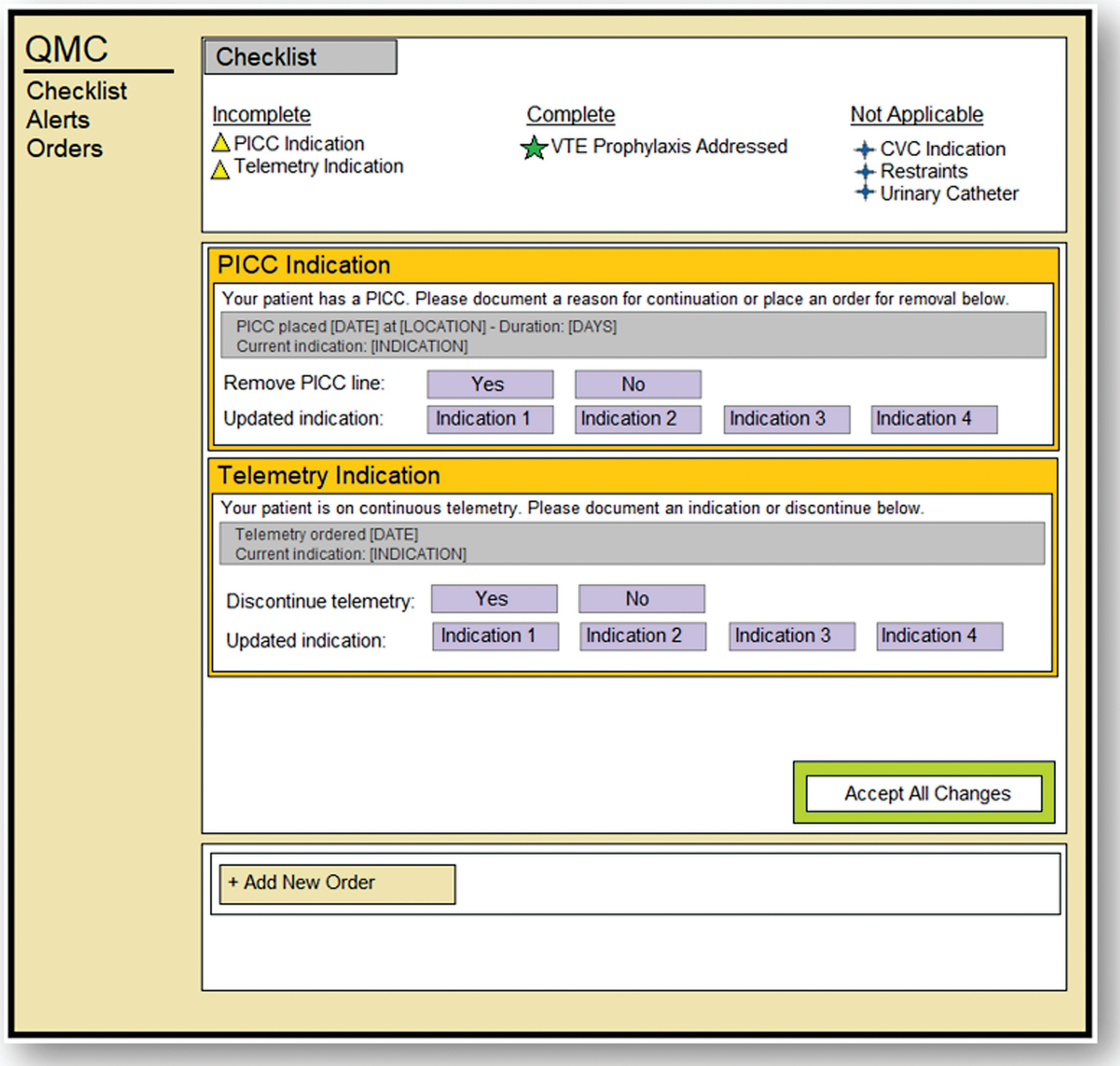


Fig. 1 Mock image of the quality metric checklist (QMC).

measures. Structured data in the form of device placement or insertion orders, indications for use, and patient facts are used to inform the QMC. Line, drain, and airway (LDA) documentation is also structured and contains valuable information about device type, location, and status. QMC rules evaluate these discrete data elements and date/time information for deficiencies or the need for clarifying information.

Measures

The outcomes for this project were reduced device duration, improved patient outcomes, and reduced CDS alert volume (►Table 2). Throughout the observation period, clinical data from the internal quality department were used, as well as past performance references. CDS data were collected from the EHR for preintervention (FY2017) and postintervention

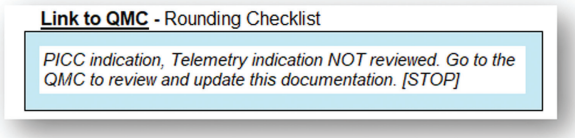


Fig. 2 What a clinician might see in a note with a deficiency. The link to quality metric checklist (QMC) is active and launches the above activity—the QMC—alongside the note workspace.

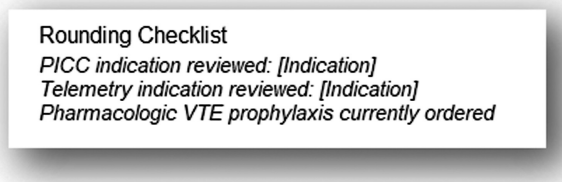


Fig. 3 What a clinician would see with a completed quality metric checklist (QMC).

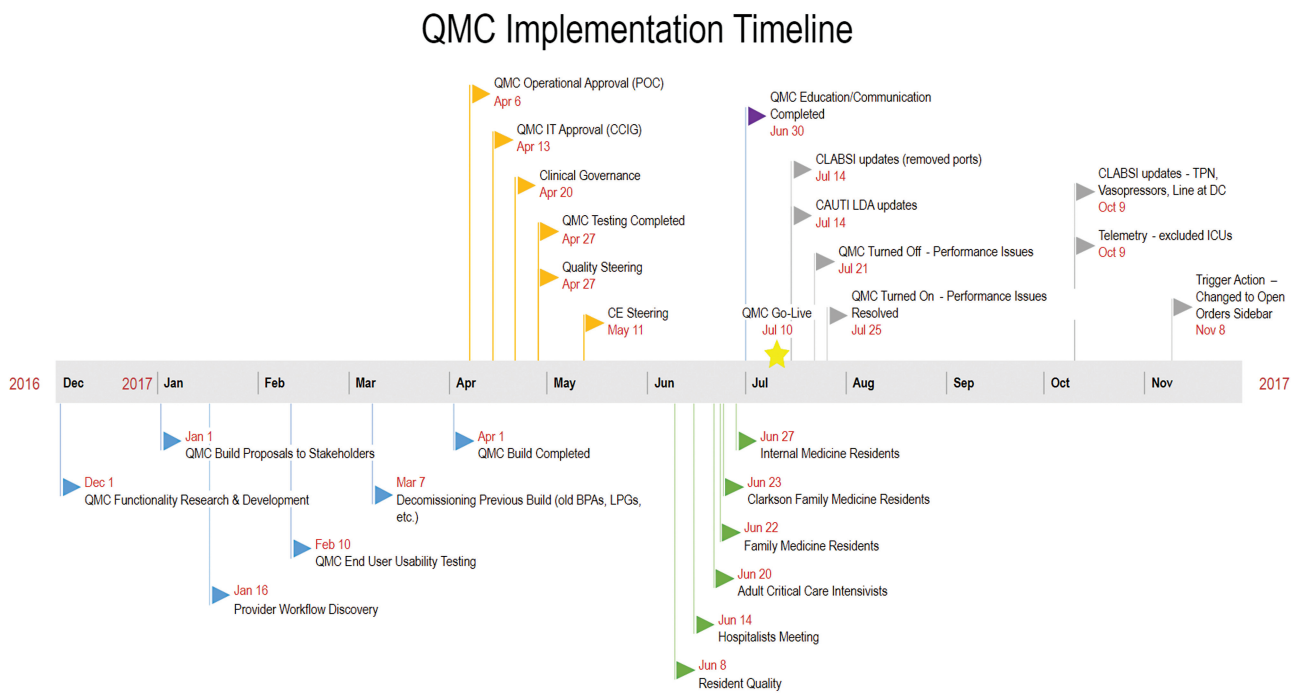


Fig. 4 Quality metric checklist (QMC) implementation timeline.

(FY2018). To preserve protected health information (PHI), patient data were de-identified. In addition to CVC, IUC, and telemetry, venous thromboembolism (VTE) and patient restraint renewal were included as part of the CDS evaluation but were not specifically part of the clinical outcome goals. The institution's quality department methodology uses the National Healthcare Safety Network (NHSN) framework along with Society for Healthcare Epidemiology of America (SHEA) compendium and Centers for Disease Control and Prevention (CDC) guidelines.

Analysis

From FY2017 to FY2018, we observed the events and compared internal quality department data. The clinical outcomes were measured using quality department reporting technique, and no adjustments were made for this observation. The CDS data for each relevant warning were extracted throughout the same time period, and FY2017 was compared with FY2018. The information was summarized using descriptive statistics such as counts, percentages, and means. The quality department calculated the savings using their key performance indicators (KPIs) to arrive at cost reductions. The value was determined by the quality department based on the additional attention that was required. This contained a standardized statistic for every illness prevented, which has a cost associated with it. If an infection was prevented, the hospital saved on the attributable cost. Savings were made when the number of patients in the infection bay decreased.

Ethical Considerations

As part of a quality improvement project, this evaluation does not constitute human subject research. Authors have no conflicts of interest.

Results

Initial Steps of the Intervention

After development and testing of redesigned CDS tools, the legacy alerts were retired and replaced by the updated CDS tools and QMC activity in FY2018. There were no modifications made to the intervention over time. It has remained in the EHR since its implementation in FY2018.

Details of the Process Measures and Outcome

Device duration is tracked electronically through EHR documentation by clinicians inserting, attaching, monitoring, removing, or withdrawing the device. These "start" and "stop" event time stamps are considered the source of truth at the organization for device duration. To account for volume-related changes in device duration, the additional metric of "line days per patient days" is reported. Quality department methodology for defining CLABSI and CAUTI events is complex and adheres to external standards often requiring manual case review. We elected to use their data as reported by the organization rather than define a unique metric for CLABSI and CAUTI for the purpose of this intervention. Similarly, the organization had adopted and refined standard internal "cost per case" values, which were used here.

Contextual Elements That Interacted with the Intervention(s)

There are workflow changes and deviations that cannot be compensated for because this was a real-world operational system implementation without a control. Although all patients and clinicians were subject to the same CDS rules and alerts, not all clinicians interacted in the same way with CDS instruments. Dedicated training and education on the purpose and benefits of the redesigned CDS and QMC preceded

implementation in FY2018. Additional sessions were needed in some specialty areas to improve understanding and adoption.

Quality Outcomes

There are no missing data for the defined outcomes. Baseline values for metrics with the CDS tools enabled are shown in ►Figs. 5–7.

Clinical outcomes pre- and postintervention. During the observation period, reductions were noted in all primary domains. Total IUC time reduced by 5.8%, total CVC duration decreased by 6.1%, and mean telemetry duration decreased by 16.94%.

IUC QMC Outcomes (►Fig. 5). IUC total duration decreased 5.8%. IUC line days per patient decreased 4.68%. Observed CAUTI rate (per 1,000 patient days) decreased 8.1%. CAUTI-associated cost decreased from $411,236 in FY2017 to $357,126 in FY2018.

CVC QMC outcomes (►Fig. 6). CVC total duration days decreased 6.1%. CVC line days per patient days decreased 12.8%. Observed CLABSI rate (per 1,000 patient days) decreased 2.8%. CLABSI-associated cost decreased from $2.94 million in FY2017 to $2.67 million in FY2018.

Telemetry QMC Outcomes (►Fig. 7). Mean telemetry duration decreased 16.94% from 3.72 to 3.09 days per patient. Based on estimated telemetry cost per patient per day, telemetry duration savings in FY2018 was approximately $602,000.

Decision Support Outcomes

Following implementation of the redesigned CDS tools and QMC activity, total alert volume decreased by 23.8%. Per patient alert volume decreased by 18.6% from 1.18 alerts per patient per day in FY2017 to 0.96 alerts per patient per day in FY2018 (►Table 4). Alert response rate increased from 10.0 to 72.4%.

Discussion

Summary

CVC, IUC, and telemetry duration decreased when measured in total line days, line days per patient days, and mean telemetry duration per patient. The observed rate of CLABSI and CAUTI decreased as well. Cost-savings were realized as a result of reported reductions in CLABSI, CAUTI, and telemetry length. Decision support results also show a reduction in CDS alert volume and a significant increase in CDS alert response rate. There are links to presentations offered by the vendor, as well as a package that may be downloaded to an institution's EHR system.[13,14]

Interpretation

Addressing the quality of clinical workflows and CDS is a necessary step in improving EHR usability.[15–17] The alarm response rate increased to 72.4% and the overall volume of alerts lowered by restructuring CDS to be more accurate and

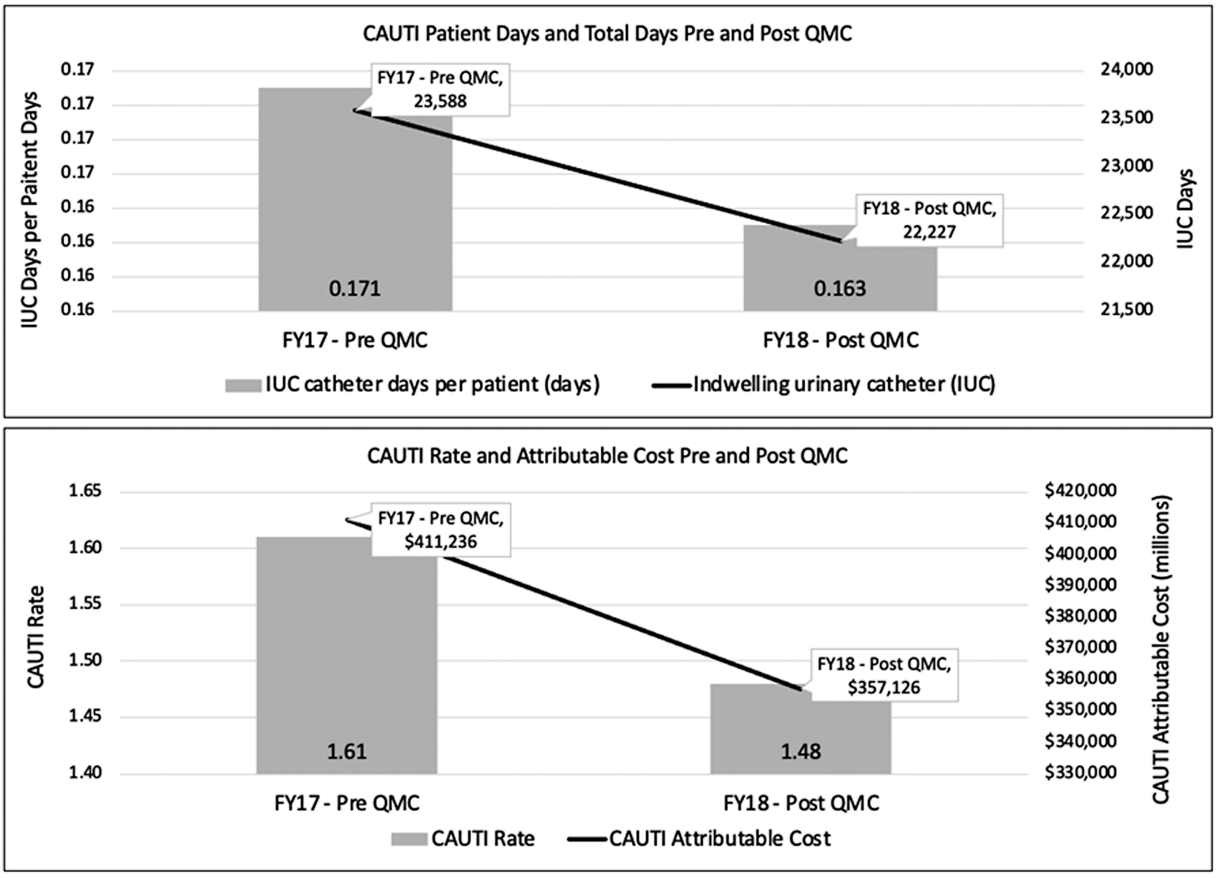
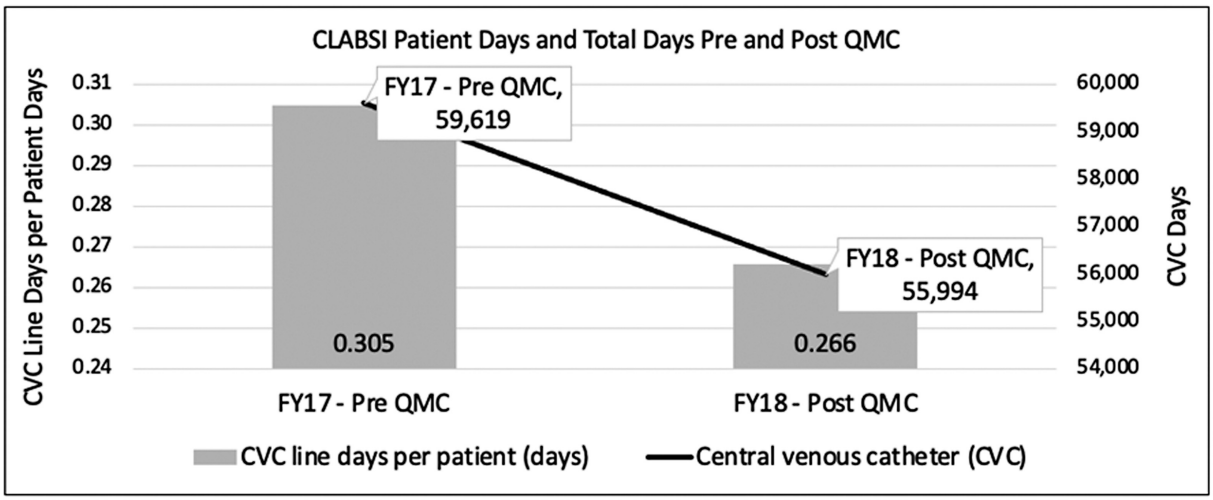


Fig. 5 Indwelling urinary catheter (IUC) outcomes. Number of alerts pre- and postintervention.



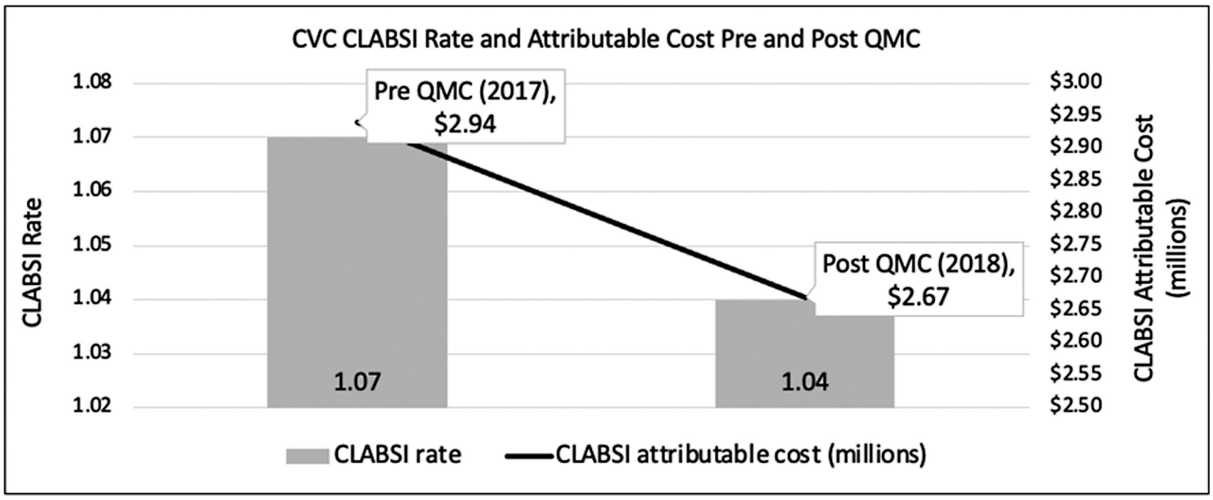


Fig. 6 Central venous catheter (CVC) outcomes. CLABSI, central line–associated bloodstream infection; QMC, quality metric checklist.

incorporating alerts into documentation and order workflows. Prior to our intervention, there was no EHR alert prompting users to review utility of ongoing CVC insertion. The results of this project suggest that improved CDS design may lead to improved provider response rates and positively impact duration of devices, reduce CLABSI and CAUTI rates, and reduce health-system-associated costs. In addition to observed improvement in safety and cost outcomes, the frequency of CDS alerts decreased, while response rate increased. We believe the QMC project improved CDS

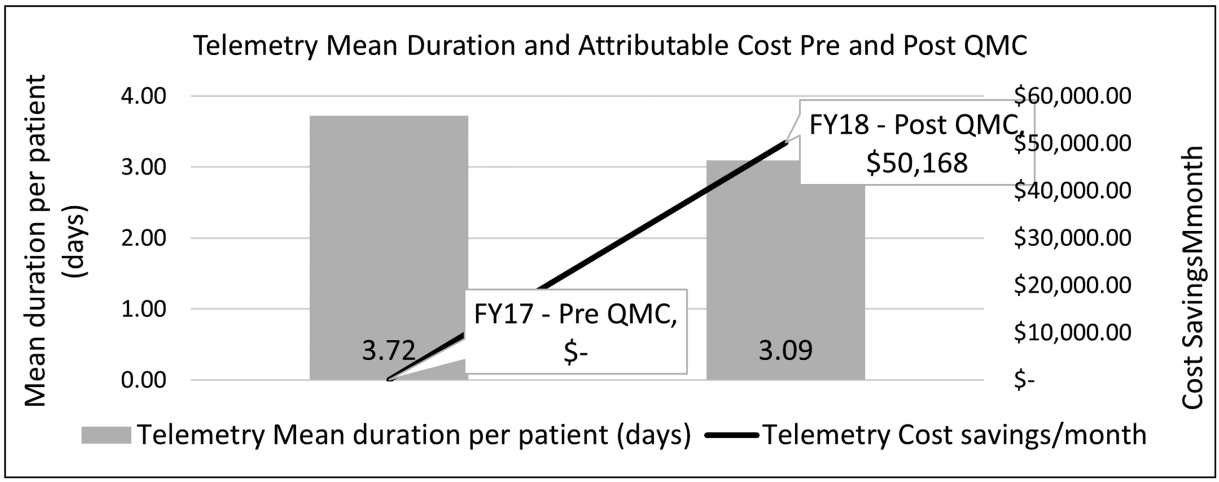


Fig. 7 Telemetry mean duration and attributable cost pre- and post-QMC. QMC, quality metric checklist.

Table 4 Number of alerts pre- and postintervention

		FY17 Pre-QMC	FY18 Post-QMC	Difference	% change
Central venous catheter (CVC)					
	Alerts	N/A	14,989	14,989	N/A
	Response rate	N/A	12,291 (82.0%)	82.0%	N/A
Indwelling urinary catheter (IUC)					
	Alerts	7,407	10,354	2,947	39.8
	Response rate	10.9%	80.0%	69.1%	633.9
Telemetry					
	Alerts	19,529	21,251	1,722	8.8
	Response rate	18.9%	84.5%	65.6%	347.1
VTE					
	Alerts	41,220	9,002	−32,218	−78.2
	Response rate	5.5%	42.1%	36.6%	665.5
Restraints					
	Alerts	13,034	6,303	−6,731	−51.6
	Response rate	10.7%	39.7%	29.0%	271.0
Total					
	Alerts	81,190	61,899	−19,291	−23.8
	Alerts per patient per day	1.18	0.96	−0.22	−18.6
	Response rate	10.0%	72.4%	62.4%	624.0

Abbreviations: QMC, quality metric checklist; VTE, venous thromboembolism.

accuracy and most importantly delivered it at a time in the workflow where providers were ready to act and found the alerts useful. The note-based workflow was accepted by providers as they were already spending time manually documenting similar information. Providers did receive feedback when health system goals were reached, such as reduction in mean telemetry duration. Future research could look into the impact of redesigned CDS in a controlled environment, the patient-specific impact of increased alert response rate, and quantifying the unique impact on alert reduction realized by improving CDS rules versus appropriate alert response reducing duplicate or recurrent ignored alerts.

Lessons Learned

This project highlighted several key factors to consider when implementing EHR clinical workflow enhancements. First, highly skilled informaticians and system analysts were essential in designing complicated EHR tools, and collaboration with clinical champions to understand and appropriately develop workflow is necessary. Engaging clinical partners throughout the development lifecycle gave the project team direction and assisted in integrating the clinical workflow with CDS technologies in a way that promoted responsiveness.

Second, as the project progressed, the team identified workflow variation across clinical teams and service lines that required additional education to optimize the use of CDS tools. Developing tools that were flexible enough to be used across clinical workflows without interruption allowed the benefits to be realized by a broad range of clinical service lines.

Third, while working diligently to continuously improve the workflow and CDS tools, the team also took adequate time to celebrate the successes and share the learnings with other organizations. This crucial step energized the team to continue improving and allowed for feedback from other organizations when successes were shared extramurally.

Fourth, the design of CDS tools did use complex rule logic and evaluation. Because of how frequently the system referred to a complex rule, the initial implementation caused some unexpected system performance concerns. To improve the system performance, we elected to decrease the frequency of rule evaluation from continuous to a specific time interval. We also decided to avoid triggering complex rule evaluations in clinical workspaces with high-traffic EHR navigation points. The landing page that shows upon opening a patient chart in an ICU environment is an example of a high-traffic navigation point. Because the landing page loads frequently throughout EHR travel, it may cause system performance concerns if a complex rule is embedded in and triggered by accessing the landing page.

The final key learning for the project team was that education resources are no longer devoted to this CDS because the CDS design is very intuitive. There was a lot of education at the beginning of implementation, especially with high-priority service lines like critical care medicine,

hospital medicine, and family medicine. The CDS tool was adopted rapidly when clinicians realized the benefits of the new workflow of just one single prompt that leads to the activity where you could address all the outstanding orders. The clinician documentation embedded workflow was adopted even more rapidly and education is no longer needed.

Future Work

The health system's quality improvement team continues to improve the CDS by adding new criteria for certain alerts or changing criteria for alerts over time based on feedback in the area of performance and effectiveness of decision support. When there are changes because a new item gets added, for example, to improve the quality and completeness of LDA documentation, the QMC tools are updated to accurately reflect the new goals. There is no plan to switch alerts off because the organizational goal is 0 for all quality improvement events, which will require decision support to achieve for the foreseeable future.

Limitation

There is no control group for outcome measurement. Other factors that were not accounted for could have influenced changes in the outcome measurements. While device duration reduction targets are well established, we cannot claim with certainty that all lowered durations were related with beneficial results in all situations. If not implemented correctly, multiple iterations of this note-based CDS could contribute to scope creep. This project lacks statistical analysis, which may limit generalizability.

Conclusion

Effective CDS adoption requires ease of use and appropriate timing. Integrating CDS into the documentation process raises provider awareness of the outstanding quality measures. When providers are ready to address them, it is during the documentation process. We included the advantage of the provider's orders informing documentation, which reduced repetition as providers simply need to manage the orders, and the documentation is created. This is what distinguishes this initiative from others of its kind. Our approach to CDS enhancement has the potential to improve future CDS design and implementation. A well-designed, integrated CDS tool can improve clinician response rate and reduce interruptive alert volume. To reduce CVC, IUC, and telemetry duration, CDS interventions are frequently implemented to achieve the goals of preventing unnecessary monitoring, reducing adverse events, and decreasing health care costs.[18,19] Our project shows that redesigning and improving CDS tools can improve physician response rate, reduce CDS alert volume, and shorten device duration. Thoughtful redesign and improvement of CDS into clinical workflows may improve alert response rate, decrease workflow interruption, and improve relevant quality outcomes. Others can replicate this project by viewing the links to presentations hosted by the vendor.[13,14] Additionally, a package is available for download to an institution's EHR system from the vendor's Web site.

Clinical Relevance Statement

This intervention can be implemented within the EHR and reduce CDS workload for clinicians, reduce device duration, and reduce costs associated with inpatient care. Iterative efforts to improve performance quality should focus on domains with apparent opportunity. Thoughtful redesign and improvement of CDS into clinical workflows may improve alert response rate, decrease workflow interruption, and improve relevant quality outcomes. Future projects could deploy more innovative solutions, such as artificial intelligence, collaboration-focused solutions, such as identifying and collaborating with physician champions from low-adoption specialist areas, or more use of workflow integration, to further enhance adoption.

Protection of Human and Animal Subjects

As a quality improvement project, this evaluation does not constitute human subject research as defined at 45CFR46.102 - Subpart A: Basic U.S. Department of Health and Human Services Policy for Protection of Human Research Subjects. IRB approval was unnecessary. The authors have no conflict of interest.

Data Availability Statement

Due to commercial restrictions, data cannot be shared publicly, so supporting data are not available.

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Conflict of Interest

None declared.

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