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MAJOR ARTICLE

Improving Appropriate Diagnosis of *Clostridioides difficile* Infection Through an Enteric Pathogen Order Set With Computerized Clinical Decision Support: An Interrupted Time Series Analysis

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Background. Inappropriate testing for *Clostridioides difficile* leads to overdiagnosis of *C difficile* infection (CDI). We determined the effect of a computerized clinical decision support (CCDS) order set on *C difficile* polymerase chain reaction (PCR) test utilization and clinical outcomes.

Methods. This study is an interrupted time series analysis comparing *C difficile* PCR test utilization, hospital-onset CDI (HO-CDI) rates, and clinical outcomes before and after implementation of a CCDS order set at 2 academic medical centers: University of Washington Medical Center (UWMC) and Harborview Medical Center (HMC).

Results. Compared with the 20-month preintervention period, during the 12-month postimplementation of the CCDS order set, there was an immediate and sustained reduction in *C difficile* PCR test utilization rates at both hospitals (HMC, −28.2% [95% confidence interval {CI}, −43.0% to −9.4%], $P = .005$; UWMC, −27.4%, [95% CI, −37.5% to −15.6%], $P < .001$). There was a significant reduction in rates of *C difficile* tests ordered in the setting of laxatives (HMC, −60.8% [95% CI, −74.3% to −40.1%], $P < .001$; UWMC, −37.3%, [95% CI, −58.2% to −5.9%], $P = .02$). The intervention was associated with an increase in the *C difficile* test positivity rate at HMC ($P = .01$). There were no significant differences in HO-CDI rates or in the proportion of patients with HO-CDI who developed severe CDI or CDI-associated complications including intensive care unit transfer, extended length of stay, 30-day mortality, and toxic megacolon.

Conclusions. Computerized clinical decision support tools can improve *C difficile* diagnostic test stewardship without causing harm. Additional studies are needed to identify key elements of CCDS tools to further optimize *C difficile* testing and assess their effect on adverse clinical outcomes.

Keywords. *C difficile* infection; diagnostic stewardship; *Clostridioides difficile*; computerized clinical decision support; interrupted time series analysis.

Clostridioides difficile is the most commonly reported pathogen responsible for healthcare-associated infections [1]. However, an emerging body of literature suggest that a substantial portion of reported *C difficile* infections (CDI) are related to inappropriate testing of colonized patients [2, 3]. Testing of patients without true disease leads to overdiagnosis of asymptomatically colonized patients as having CDI and unnecessary treatment, which may result in adverse drug effects, further disruption of the gut microbiota, and excess healthcare costs [4–6]. The 2017 Infectious Disease Society of America (IDSA) and the Society for Healthcare Epidemiology of America (SHEA) Clinical Practice Guidelines for *Clostridium difficile* Infection in Adults and Children and the American Board of Internal Medicine (ABIM) Choosing Wisely initiative recommend testing only those patients who are likely to have CDI [7–9]. Although several studies have assessed the role of electronic decision support tools on process outcomes such as *C difficile* test orders [10–16], few have evaluated the impact on adverse clinical outcomes [17].

On August 29, 2018, a computerized clinical decision support (CCDS) enteric pathogen order set was implemented at 2 hospitals within UW Medicine to guide providers towards

Received 13 April 2020; editorial decision 10 August 2020; accepted 13 August 2020.

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Open Forum Infectious Diseases®

DOI: 10.1093/ofid/ofaa366

appropriate use of the stand-alone *C difficile* polymerase chain reaction (PCR) and a multiplex enteric pathogen panel. In this study, we evaluated the effect of the CCDS enteric pathogen order set on *C difficile* PCR test utilization and clinical outcomes.

METHODS

Setting and Study Population

This was a quasi-experimental study conducted at 2 academic medical centers within the UW Medicine system. The University of Washington Medical Center (UWMC) is a 570-bed tertiary care center that also serves a large population of immunosuppressed patients including solid organ and hematopoietic stem cell transplant recipients. Harborview Medical Center (HMC) is a 413-bed acute care hospital that serves as a public safety-net hospital for King County, and the level 1 trauma and burn center for Washington, Wyoming, Alaska, Montana, and Idaho. Medical housestaff rotate between the 2 different institutions.

Patient Consent Statement

This study was approved by the University of Washington Institutional Review Board Committee with a waiver of informed consent.

Intervention

We developed an electronic order set to guide enteric pathogen test ordering within a Cerner platform (Cerner Corp., Kansas City, MO). Providers were automatically directed to use the order set when testing for *C difficile* and other enteric pathogens. The order set includes guidelines that preferentially recommend testing patients with new-onset, hospital-associated diarrhea (≥3 loose stools/day) in the absence of laxative use with *C difficile* PCR (Supplemental Figure 1). The order set prompts providers to order a multiplex enteric pathogen panel only for those presenting with community-onset diarrhea (hospitalization for ≤3 days). Computerized clinical decision support tools were implemented as part of the order set to guide appropriate testing for *C difficile*. The order set identified patients who received laxatives within the preceding 48 hours and included a "hard stop" alert indicating the laxative name and time administered, along with a message "*C. difficile* testing is generally NOT indicated for patients receiving laxatives. Contact Lab Medicine Resident on-call to place order, if testing is still indicated." (Supplemental Figure 2). Repeat testing within 14 days of a positive *C difficile* test and within 7 days of a negative test was actively discouraged via an alert that fired if an order was placed within this time window advising the provider to contact the lab medicine resident on-call to place the order if testing was believed to be indicated (Supplemental Figure 3). Approximately 2 months before implementation, an educational campaign informed providers and nurses of the planned changes including a memo distributed through the medical director's office at the 2 hospitals and presentations to key stakeholders. The CCDS enteric pathogen order set went live on August 29, 2018.

Before implementation of the order set, a multidisciplinary *C difficile* reduction program was implemented at HMC on September 18, 2017, which included provider education, nursing engagement, and restrictions on repeat *C difficile* PCR testing for nurse-driven orders. Although UWMC had a comprehensive CDI prevention and antimicrobial stewardship program throughout the 2 time periods, there were no programmatic efforts specifically targeting *C difficile* testing until the implementation of the CCDS order set.

Data Collection

We electronically extracted the following data between January 1, 2017 and August 31, 2019: *C difficile* PCR test orders and results as well as laxative use 48 hours before *C difficile* PCR test order. Hospital-onset CDI (HO-CDI) rates and HO-CDI cases during the study period were provided by the infection prevention teams. Among the HO-CDI cases, we electronically extracted the following: white blood cell count (WBC) > 15 000 cells/mL, serum creatinine >1.5 mg/dL, and intensive care unit (ICU) transfer within 7 days after a positive *C difficile* PCR test result, hospital stay beyond 7 days after a positive *C difficile* PCR test result, and deaths within 30 days after a positive *C difficile* PCR test result. Among HO-CDI cases, we electronically captured those in which the keywords "toxic megacolon" and "colectomy" were documented during the same hospitalization as the positive *C difficile* PCR test result; chart review was conducted (J.Z.) and verified by a physician (C.L.) to determine whether the patient experienced toxic megacolon and/or underwent colectomy due to toxic megacolon as a complication of their CDI.

Laboratory Methods

Stool samples tested for *C difficile* using the Xpert *C. difficile* PCR Assay (Cepheid, Sunnyvale, CA) were collected in a sterile media-free container. Formed specimens and those from patients <2 years of age were rejected for testing on the Xpert platform. The enteric pathogen panel consisted of the FilmArray Gastrointestinal Panel (Biofire, Salt Lake City, UT) and limited culture on blood agar, primarily for detection of *Aeromonas*. Samples for the enteric pathogen panel were primarily received in Cary-Blair medium, and therefore their formed status could not be assessed in the laboratory.

Statistical Analysis

Data were summarized by calendar month of the study period. The preintervention period was defined as January 1, 2017 to August 31, 2018, and the postintervention period was defined as September 1, 2018 to August 31, 2019. At HMC, the preintervention period was further divided into a pre-*C difficile* reduction program period from January

1, 2017 to September 17, 2017 and a post-*C difficile* reduction program period from September 18, 2017 to August 31, 2018. The primary outcome of this study was *C difficile* PCR test utilization rate as measured by number of tests ordered per 10 000 patient days. We conducted an interrupted time series (ITS) analysis using segmented regression with negative binomial distribution to test for changes in the slope and level of *C difficile* test rate from pre- to postintervention [18]. The dependent variable was the number of tests each month, and the logarithm of the total number of patient-days was included as an offset. Given that UWMC and HMC consist of different patient populations with some differences in preintervention practices, the medical centers were modeled separately (Supplemental Methods). For UWMC, we included a single linear term for the preintervention slope, whereas for HMC, we included an additional term to allow for separate preintervention slopes before and after implementation of the *C difficile* reduction program. Models for both sites included a term for a level change after the intervention and a single linear term for postintervention slope. We tested for autocorrelation by examining patterns in residuals over time and using the Durbin-Watson test [19]. Model estimates were exponentiated to compute the incidence rate ratio (IRR) and presented as the percentage change in rates by computing IRR − 1. Slope estimates were presented for preintervention and postintervention time periods and represent the percentage change per month.

Secondary outcome measures included *C difficile* testing within 48 hours after laxative administration, percentage of positive *C difficile* test results over all orders, and HO-CDI rates. These outcomes were analyzed using segmented regression models similar to those described for the primary outcome. We used quasi-Poisson models to evaluate the total number of *C difficile* tests ordered within 48 hours after laxative use among all patient-days and logistic regression models to evaluate the proportion of all *C difficile* tests that were ordered within 48 hours of previous laxative administration. Logistic regression models were also used for the proportion of *C difficile* tests that were positive; these model estimates were presented as odds ratios (ORs) with 95% confidence intervals (CIs). Negative binomial models were used for HO-CDI rates among all patient-days.

We evaluated clinical outcomes among patients with HO-CDI before and after the intervention including WBC > 15 000 cells/mL, serum creatinine >1.5 mg/dL, and ICU transfer within 7 days after a positive *C difficile* test, hospital stay beyond 7 days after a positive *C difficile* test, deaths within 30 days after a positive *C difficile* test, and diagnosis of toxic megacolon with or without colectomy after a positive *C difficile* test that occurred during the same hospitalization. Each of these binary outcomes was tested separately, and each measurement of the outcome type was considered independent; aggregate frequencies before and after the intervention were compared using a χ^2 test or Fisher's exact test. All analyses were performed using the R computing environment (version 3.5.1).

RESULTS

During the preintervention period (January 1, 2017–August 31, 2018), 6053 *C difficile* PCR tests were ordered over 417 100 patient days (145.1 tests/10 000 patient-days); during the postintervention period (September 1, 2018–August 31, 2019), 1812 *C difficile* PCR tests were ordered over 259 742 patient days (69.8 tests/10 000 patient-days). Table 1 describes results of the ITS analysis and indicates a significant decline in *C difficile* PCR order rate in the preintervention period at both hospitals. With implementation of the CCDS order set in August 2018, there was an immediate level change or drop in test utilization at both hospitals (Figure 1A). After accounting for the initial decreasing trend in the preintervention period, the negative binomial segmented regression model estimated a 27.4% and a 28.2% reduction in the rates of *C difficile* PCR tests ordered at UWMC and HMC, respectively, after the intervention. For UWMC, postintervention trends in test rates (1.7% decline per month) were similar to preintervention trends (1.2% decline per month; $P = .58$ for change in slopes). In contrast, HMC postintervention test rates stabilized with no evidence of additional decline (−0.8% per month), which was significantly different from the steeper slopes observed in the preintervention period (−2.4% and −6.8%; $P < .001$ for change in slopes from pre- to postintervention).

Next, we evaluated the effect of the CCDS order set on the relative contribution of *C difficile* tests ordered in the setting of laxatives among all tests ordered. After the intervention, the proportion of *C difficile* tests ordered in the setting of laxative use dropped from 39.3% and 16% at HMC and UWMC, respectively, in August 2018 to 28.9% and 9.6% in September 2018. A significant reduction, or level change, in the proportion

Table 1. Percentage Rate Change for All *Clostridioides difficile* PCR Test Orders

Model Parameter	Percentage Change (95% CI)	*P* Value
Harborview Medical Center		
Intervention level change	−28.2% (−43.0% to −9.4%)	.005
Preintervention, pre-CDI program slope (per month)	−2.4% (−4.3% to −0.5%)	.016
Preintervention, post-CDI program slope (per month)	−6.8% (−8.6% to −5.0%)	<.001
Postintervention slope (per month)	−0.8% (−3.3% to 1.8%)	.55
University of Washington Medical Center		
Intervention Level Change	−27.4% (−37.5% to −15.6%)	<.001
Preintervention slope (per month)	−1.2% (−1.8% to −0.5%)	.001
Postintervention slope (per month)	−1.7% (−3.4% to 0.1%)	.07

Abbreviations: CDI, *C difficile* infection; CI, confidence interval; PCR, polymerase chain reaction.

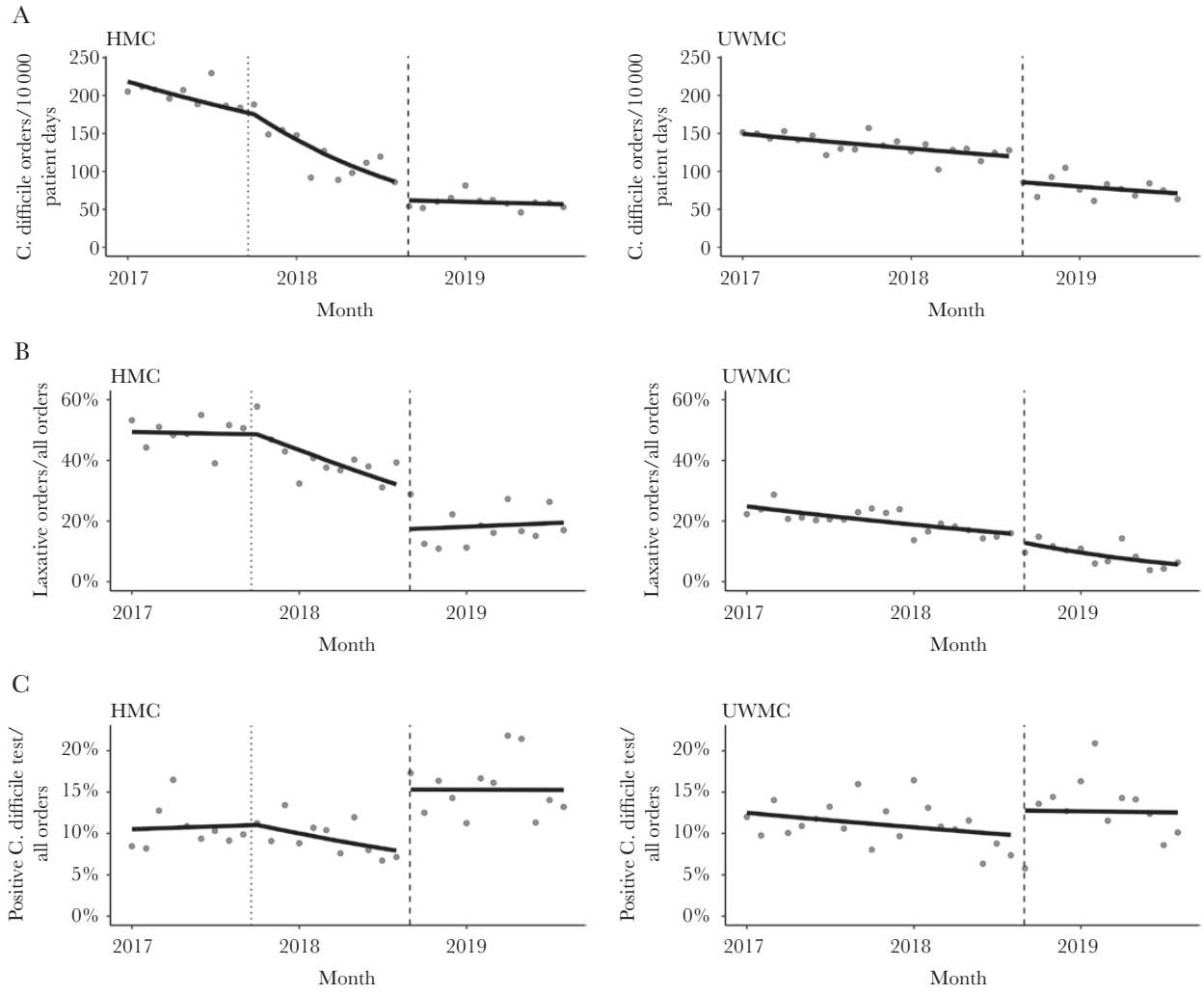

Figure 1. (A) Fitted Trends in Monthly Rate of *C. difficile* PCR Test Orders. HMC = Harborview Medical Center; UWMC = University of Washington Medical Center. Filled circles represent observed data and solid lines represent fitted trends from a negative binomial segmented regression model. The black dashed vertical line in each figure represents the date of the CCDS order set implementation. The dotted vertical line in HMC represents the implementation date of the *C. difficile* reduction program; (B) Monthly Proportions of *C. difficile* PCR Test Orders Obtained within 48 Hours of Laxative Use among all *C. difficile* PCR Test Orders; (C) Fitted Trends in Monthly Proportions of Positive *C. difficile* Test Results among all *C. difficile* PCR Test Orders.

of *C difficile* tests ordered in the setting of laxatives among all *C difficile* test orders was observed at HMC (OR = 0.45; 95% CI, 0.29–0.69; $P < .001$) but was not observed at UWMC (OR = 0.78; 95% CI, 0.53–1.15; $P = .45$) (Table 2; Figure 1B). We also evaluated the effect of the CCDS order set on *C difficile* testing rates in the setting of laxative use, among all patient days. Although a decline in *C difficile* testing in the setting of laxatives was observed preintervention, a significant reduction in the rate of *C difficile* PCR orders within 48 hours of laxative administration of greater magnitude was observed after order set implementation (HMC, −60.8% [95% CI, −74.3% to −40.1%], $P < .001$; UWMC, −37.3% [95% CI, −58.2% to −5.9%], $P = .02$) (Supplemental Table 1).

To assess the effect of the CCDS order set on *C difficile* test positivity rate, we evaluated monthly trends in proportion of

Table 2. Odds Ratios for Proportion of *Clostridioides difficile* PCR Test Orders Within 48 Hours of Laxative Use

Model Parameter	Odds Ratio (95% CI)	*P* Value
Harborview Medical Center		
Intervention level change	0.45 (0.29–0.69)	<.001
Preintervention, pre-CDI program slope (per month)	1.0 (0.97–1.02)	.8
Preintervention, post-CDI program slope (per month)	0.93 (0.91–0.96)	<.001
Postintervention slope (per month)	1.01 (0.96–1.07)	.67
University of Washington Medical Center		
Intervention level change	0.78 (0.53–1.15)	.45
Preintervention slope (per month)	0.97 (0.96–0.99)	<.001
Postintervention slope (per month)	0.92 (0.87–0.98)	.01

Abbreviations: CDI, *C difficile* infection; CI, confidence interval; PCR, polymerase chain reaction.

positive *C difficile* tests among all tests ordered. A significant increase, or level change, in the *C difficile* test positivity rate was observed at HMC (OR = 2.1; 95% CI, 1.2 to 3.6; $P = .01$) but was not observed at UWMC (OR = 1.3; 95% CI, 0.9 to 2.0; $P = .18$) (Supplemental Table 2 and Figure 1C).

Hospital-onset CDI rates were evaluated during the study period. No significant differences were observed in rates of HO-CDI at the 2 hospitals between the 2 study periods (Supplemental Table 3 and Supplemental Figure 4). We did not detect significant residual autocorrelation in any of the segmented regression models we examined, indicating that our model assumption of independent observations was not violated.

We assessed the impact of reduced testing on delayed diagnoses of severe CDI by evaluating potential complications of CDI. Among the 385 HO-CDI cases in the preintervention period and 177 HO-CDI cases in the postintervention period, we observed no significant differences in the proportion of patients with WBC > 15 000 cells/mL, serum creatinine >1.5 mg/dL, or ICU transfer within 7 days after a positive *C difficile* test, length of hospital stay beyond 7 days after a positive *C difficile* test, and the proportion of patients who died within 30 days of a positive *C difficile* test (Table 3). In the preintervention period, 5 (1.3%) of 385 patients had a diagnosis of HO-CDI that was associated with toxic megacolon compared with 0 (0%) of 177 patients in the postintervention period ($P = .33$).

DISCUSSION

We demonstrated that implementation of a CCDS enteric pathogen order set as a diagnostic test stewardship strategy led to a significant and sustained reduction in the rate of *C difficile* PCR test orders in the 12-month postintervention period. We observed a reduction in testing in the setting of laxative use and an increase in the proportion of positive *C difficile* tests among all *C difficile* tests ordered at one hospital and a trend towards increased *C difficile* test positivity rate at the other hospital. This suggests that the CCDS enteric pathogen order set directed clinicians towards more appropriate testing of those patients with an increased pretest probability of CDI. Finally, despite a reduction in tests ordered, we did not observe any adverse effects on patient outcome among those diagnosed with HO-CDI.

A variety of strategies have been implemented in different settings to improve *C difficile* diagnostic stewardship (Table 4). With the exception of a few studies that primarily used a laboratory-initiated intervention [20, 21] in conjunction with clinician education to limit inappropriate testing, CCDS tools to direct appropriate testing by clinicians have emerged as an important strategy to improve *C difficile* diagnostic test stewardship. Our findings are consistent with several studies demonstrating the value of CCDS tools in directing appropriate *C difficile* testing [11–13, 15, 16, 22]. For example, Mizusawa et al [13] demonstrated that an Epic platform-based CCDS best practice alert (BPA) activated by orders placed in the setting of recent laxative administration and early repeat testing resulted in a significant reduction in rates of *C difficile* testing.

An important consideration when implementing diagnostic stewardship interventions is assessing the potential for unintended adverse consequences by more restrictive testing approaches. A recent study found similar rates of serious outcomes among patients who tested positive for *C difficile* who did and did not receive laxatives and raises concern that exclusion of patients receiving recent laxatives from testing could lead to delayed or missed diagnoses of severe CDI [23]. As many institutions have incorporated CCDS tools that restrict testing in the setting of laxatives, the findings of the above study may have important implications. Although a number of studies have demonstrated that implementation of such tools has led to a decline in *C difficile* testing and HO-*C difficile* events [11, 12, 15, 22], very few have systematically evaluated the potential impact of CCDS interventions on clinical and safety outcomes [17]. A CCDS tool directing providers to consider stopping laxatives and reassess in 24 hours before ordering *C difficile* testing decreased testing in the setting of laxative use [16]; however, a small, but nonsignificant increase in the proportion of patients with *C difficile*-related complications was observed between the preintervention and postintervention periods [16]. In contrast, another study of 139 patients managed by providers who followed an Epic platform-based CCDS BPA and did not pursue *C difficile* testing found no adverse events including CDI-associated death, or delayed diagnosis of CDI or associated ileus or megacolon [13]. In our study, we did not observe any differences in the pre- and postintervention periods with respect to severe CDI or complications associated with CDI suggesting that any potential delays in testing resulting from the intervention did not have unintended adverse consequences.

Table 3. Clinical Outcomes Associated With Hospital-Onset *Clostridioides difficile* Cases in the Pre- and Postintervention Periods

Clinical Outcomes	Preintervention N = 385	Postintervention N = 177	*P* Value
WBC > 15 000 cells/mL within 7 days	152 (39.5%)	67 (37.9%)	.78
Serum creatinine >1.5 mg/dL	97 (25.2%)	43 (24.3%)	.90
30-day all-cause mortality	34 (8.8%)	8 (4.5%)	.10
ICU admission within 7 days	12 (29.1%)	45 (25.4%)	.42
Length of hospital stay beyond 7 days after positive *C diff* PCR test	245 (63.6%)	122 (69.5%)	.21
Toxic megacolon identified as complication of CDI	5 (1.3%)	0 (0%)	.33

Abbreviations: *C diff*, *C difficile*; CDI, *C difficile* infection; ICU, intensive care unit; PCR, polymerase chain reaction; WBC, white blood cells.

Table 4. *Clostridioides difficile* Diagnostic Stewardship Strategies

Author, Year	Provider Directed CCDS-Based Intervention	Prospective Audit and Feedback	EHR Platform	Intervention	Outcomes
Truong, 2017	No	No	Epic	RN stool documentation dropdown menu created with education on use; real-time Epic data tracking report including stool frequency, consistency, and laxative use within 48 hours; laboratory staff trained to review report and cancel *C difficile* orders not meeting testing criteria and repeat orders within 7 days	↓ *C difficile* test order rate, HO-CDI rates, oral vancomycin days of therapy; No difference in clinical complication rates among those with canceled orders compared with those with diarrhea and negative *C difficile* results
White, 2017	Yes	No	Sunrise Clinical Manager	*C difficile* order set created with CCDS tool identifying patients receiving prior laxatives within 36 *C difficile* and alert displayed asking providers to consider stopping laxative and reassessing in 24 hours before *C difficile* test order	↓ Proportion of *C difficile* test orders in setting of laxative use; nonsignificant increase in proportion of patients with *C difficile*-related complications
Khoury, 2018	Yes	Yes, IP team	Epic	CCDS tool prompting ordering provider to answer questions related to prior laxative use, whether diarrhea is only symptom present, whether patient is receiving medication active against *C difficile*; if answer is yes to any of these questions, alert is displayed suggesting potential inappropriate testing and justification is required. IP team daily review, cancels orders deemed to be inappropriate, notifies MD, justification required if testing desired. Laboratory canceled orders for formed stool specimens, and orders placed within 7 days of negative test or 14 days of positive test	↓ HO-CDI rates
Yen, 2018	No	No	Not specified	Hospital-wide educational campaign; laboratory canceled *C difficile* orders if stool sample not received within 24 hours or if stool did not meet the "stick test"	↓ *C difficile* monthly test orders and HO-CDI rates; no increase in *C difficile* complications observed postintervention
Quan, 2018	Yes	No	Not specified	Real-time CPOE alert requiring clinician attestation of appropriate testing criteria: ≥3 liquid stools in 24 hours, no alternate cause for diarrhea, and autopopulation of selected criteria: no laxative use within 24 hours, no previous test within 7 days, age >1 year; if testing outside criteria desired, "hard stop" requiring ID or GI approval.	↓ *C difficile* test order rate, testing while on laxatives, HO-CDI rates
Madden, 2018	Yes	No	Not specified	Educational campaign targeting GME trainees; CCDS algorithm to guide providers to test only symptomatic patients and avoid duplicate testing; financial incentive provided to GME trainees to reduce testing	↓ *C difficile* test order rates, HO-CDI rates, and SIR
Mizusawa, 2019	Yes	No	Epic	CCDS BPA activated if laxatives given within 48 hours, negative *C difficile* test within prior 7 days, positive test within prior 14 days	↓ *C difficile* test order rates; no CDI-associated complications
Christensen, 2019	Yes	Yes, AMS team	Cerner	CPOE *C difficile* PCR order modified to include criteria for testing; antimicrobial stewardship program directed provider education and prospective clinical review and preauthorization of all *C difficile* orders placed after calendar day 4 of hospital admission. CCDS built later incorporating information about testing in prior 7 days and required provider attestation of appropriate testing criteria	↓ *C difficile* test order rates, HO-CDI rates, and SIR
Munson, 2019	Yes	No	Not specified	*C difficile* order set developed containing alert recommending restricting testing to (1) patients with colonoscopic or pathologic findings of pseudomembranous colitis and (2) clinically significant diarrhea (change in stool consistency and/or frequency without other identified cause).	↓ *C difficile* test order volume, positivity rate, HO-CDI, and HO-CDI NHSN SIR
Fleming, 2019	Yes	Yes	Cerner	A decision support matrix to assist providers with appropriate orders was developed; monthly feedback provided to hospital leadership for dissemination to providers	↓ *C difficile* test order volume, positivity rate, HO-CDI, HO-CDI NHSN SIR

Abbreviations: AMS, antimicrobial stewardship; BPA, best practice alert; CCDS, computerized clinical decision support; *C difficile*, *Clostridioides difficile*; CDI, *C difficile* infection; CPOE, computer physician order entry; EHR, electronic health records; GI, gastrointestinal; GME, Graduate Medical Education; HO, hospital onset; ID, infectious diseases; IP, infection prevention; MD, medical doctor; NHSN, National Healthcare and Safety Network; PCR, polymerase chain reaction; RN, registered nurse; SIR, Standardized Infection Ratio.

Although we were unaware of any changes in our patient population during the study period, we were unable to account for potential ward/service level differences that may have affected these outcomes.

The CCDS enteric pathogen order set did not seem to have an impact on HO-CDI rates. Although the order set provided guidance directing clinicians away from testing in the absence of having 3 or more loose stools in a 24-hour period, due to inconsistent documentation of stool frequency and quality, we were not able to incorporate CCDS alerts targeting inappropriate testing among patients who did not meet these criteria. It is possible that a CCDS tool that directly incorporated such criteria into an alert or that required provider attestation of appropriate testing criteria could have had a greater impact on HO-CDI rates as observed in other studies [12, 15].

Based on data from the first year postintervention, we estimated an annualized cost-savings of $67 935 based solely on the cost per test using the 2020 Medicare fee schedule; because the Medicare reimbursement rate is well below true laboratory costs, the savings has the potential to be much higher for institutions implementing similar CCDS tools. Furthermore, this estimate does not account for savings related to reduction in isolation days and CDI treatment.

CONCLUSIONS

Our analysis was limited as a retrospective study at a single health system. However, the CCDS tool was deployed at 2 different centers within the same health system serving different patient populations and led to a significant reduction in testing rates in both suggesting generalizability to other institutions.

This study demonstrates that CCDS tools in the EHR can be effectively leveraged to improve *C difficile* diagnostic test stewardship without causing harm. Additional studies are needed to further assess the effect of CCDS tools on adverse clinical outcomes.

Supplementary Data

Supplementary materials are available at *Open Forum Infectious Diseases* online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

Acknowledgments

We gratefully acknowledge Deb Wahl, Andrew White, and Patrick Mathias for technical assistance in development of the computerized clinical decision support order set. We also thank Michelle McIntosh, Michelle Swetky, and Wesley Wang for assistance with data obtained through our infection prevention surveillance systems.

Financial support. This work was funded by the University of Washington Department of Medicine Value, Quality, and Safety Accelerator Grant Program.

Potential conflicts of interest. S. A. P. reports grant support from Global Life Technologies, Inc., participates in research trials with Chimerix, Inc., and Merck & Co., and currently participates in a clinical trial sponsored by National Institute of Allergy and Infectious Diseases (U01-AI132004); vaccines for this trial are provided by Sanofi-Aventis; all outside of this submitted work. All authors have submitted the ICMJE Form for Disclosure of Potential Conflicts of Interest. Conflicts that the editors consider relevant to the content of the manuscript have been disclosed.

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