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Improving Stewardship of *Clostridioides difficile* Testing with EMR and Provider Phone Calls

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ABSTRACT

Introduction. Modern laboratory techniques cannot differentiate between *Clostridium difficile* colonization and infection; therefore, testing must be indicated clinically. To reduce hospital-onset of *C. difficile* infections (HO-CDI), Ascension Via Christi Hospitals (AVCH) in Wichita intervened in three stages by introducing: 1) a *C. difficile* testing algorithm; 2) an electronic medical record (EMR)-based decision support system to enforce said algorithm; and 3) phone calls from the infection prevention department to providers to discontinue tests not collected within 24 hours of the order. The goal of this study was to determine if these interventions improved the HO-CDI rate.

Methods. At AVCH, the three study periods were compared: baseline with algorithm training only, the EMR intervention, and the EMR intervention with additional phone calls (EMR with phone calls). Data were abstracted from the hospital EMR.

Results. A total of 311 charts were reviewed. Adherence to the algorithm increased from 34% at baseline to 52% after the EMR intervention (p = 0.010). During the EMR with phone calls period, more tests were discontinued (87%; n = 39) compared to baseline (54%; n = 15) and EMR (54%; n = 15; p = 0.003). The HO-CDI rate ranged from 8.5 cases per 10,000 patient-days at baseline, to 7.9 during EMR, to 4.0 during EMR with phone calls (p = 0.007).

Conclusions. The EMR and EMR with phone call interventions were associated with a significant decrease in the HO-CDI rate and an increase in provider adherence to the algorithm.

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INTRODUCTION

Clostridioides difficile colonization is common among intestinal flora.[1] Infection is precipitated when prescribed antimicrobials disrupt the intestinal flora and lead to *C. difficile* overgrowth. *C. difficile* infections (CDI) continue to be one of the most prevalent hospital-acquired infections in the United States, comprising 12.1% of all healthcare-associated infections in 2011.[2] In 2015, CDI inpatient management was estimated to be 6.3 billion US dollars, requiring 2.4 million days of hospital stay.[3] Inpatient management of hospital-onset *C. difficile* infection (HO-CDI) is estimated to cost $34,157 per case.

In general, HO-CDI is defined as a positive *C. difficile* test collected 72 hours post-admission under the Medicare Hospital-Acquired Condition (HAC) Reduction program.[4] Hospitals with HAC scores greater than the 75th percentile among total HAC scores receive a 1% payment reduction which applies to all Medicare charges for the hospital within the applicable fiscal year.[5]

Current testing techniques may suggest the presence of the *C. difficile* toxin or organism but are unable to differentiate between asymptomatic carriers of *C. difficile* and those with true infection.[6] Therefore, laboratory testing for *C. difficile* needs to be supported by clinical indications of infection, as over-testing may lead to unneeded treatment and an increased rate of HO-CDIs, thus an inaccurate HAC score percentile.[6,7] Treatment of patients for CDI includes contact precautions and antibiotics. If the patient does not have true CDI, these put the patient at risk for anxiety, less interaction with health care workers, as well as antibiotic related adverse events such as drug-drug interactions and multidrug resistant organisms.[6,8] Unnecessary vancomycin paradoxically also has been shown to increase rates of *C. difficile*.[8]

To reduce clinically unnecessary *C. difficile* testing, Ascension Via Christi Hospitals (AVCH) introduced a *C. difficile* testing algorithm (Figure 1) along with training on its usage. To encourage usage of the testing algorithm, AVCH later introduced an electronic medical record (EMR)-based decision support system which notifies providers when ordering a *C. difficile* test that does not adhere to the testing algorithm. Similar interventions have been shown to reduce clinically unnecessary *C. difficile* testing up to 16%.[7,9,10] However, few studies have identified additional strategies that can be used in conjunction with EMR-based decision support systems to further reduce unnecessary *C. difficile* testing.[11] Therefore, AVCH supplemented their EMR-based decision support system with the assignment of a dedicated registered nurse from the infection prevention department to call ordering providers, asking them to cancel the test if it was no longer needed, based on AVCH's *C. difficile* testing algorithm.

The purpose of this study was three-fold. First, this study aimed to determine whether there was an increase in provider adherence to the AVCH *C. difficile* testing algorithm when supplemented with an EMR-based decision support system compared to algorithm training only (baseline). Second, this study examined the utility of the supplemented phone calls to prompt the cancelation of unnecessary tests. Finally, this study sought to determine if the EMR-based decision support system (with algorithm training) or the EMR system with algorithm training and phone calls intervention were associated with reductions in the HO-CDI rate.

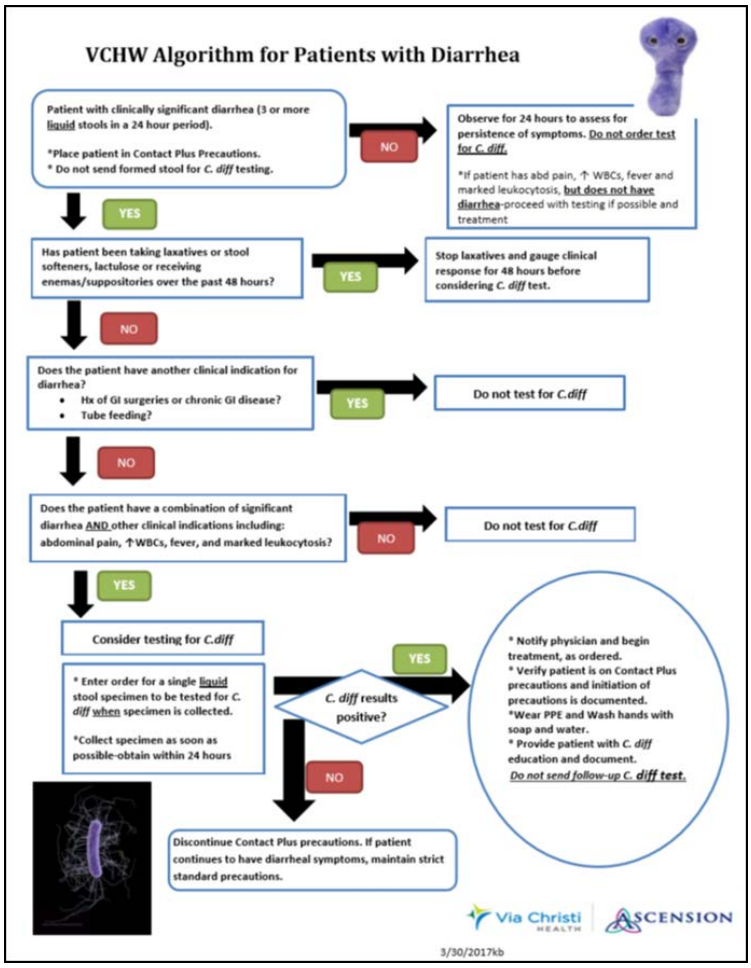

Figure 1. *C. difficile* testing algorithm.

METHODS

Participants. Patients included in this study were 18 years or older with a *C. difficile* test ordered at Ascension Via Christi Hospital (AVCH; at St. Francis or St. Joseph) in Wichita, Kansas. Study periods included: baseline (algorithm provider training only) from May 1, 2017 through September 30, 2018; EMR-based decision support system from November 1, 2018 through October 31, 2019; and EMR with a registered nurse calling ordering providers (EMR with phone calls) from November 19, 2019 through February 29, 2020. There were no exclusion criteria.

As this was a retrospective study, the microbiology lab at AVCH queried all *C. difficile* tests ordered during the study periods to identify eligible patients for this study. Among the 2,928 patients eligible for the baseline period, 131 patients were randomly sampled. Likewise, 121 patients of the 1,970 eligible patients were randomly sampled from the EMR period. All patients (n = 45) for whom a phone call was made were eligible and selected for the EMR with phone calls study period.

Instrument. All data were abstracted from AVCH's EMR via manual chart review. Demographic variables (e.g., insurance status, age) were abstracted to characterize the patient population. Abstracted information included variables related to the *C. difficile* testing algorithm, such as signs and symptoms of CDI (e.g., fever, liquid stools), pharmacologic causes of diarrhea (e.g., laxative, stool softener usage), alternate causes of diarrhea (e.g., chronic gastrointestinal disease), and previous positive *C. difficile* tests. Whether a stool sample collection was delayed (not collected within 24 hours of the test order) or within 72 hours of hospital admission also were abstracted. Data abstracted for discontinued and rejected tests included whether stool sample collection was delayed and within 72 hours of hospital admission. Indicators of severity (e.g., toxic megacolon, vasopressor usage, in hospital mortality) were abstracted to document patient outcomes.

The primary outcome of this study was the percentage of tests that were ordered according to the algorithm during the baseline and EMR periods to determine if there was a difference in algorithm adherence. The secondary outcome was the percentage of discontinued tests with delayed sample collection to determine if there was a difference between baseline, EMR, and EMR with phone calls. Finally, the overall HO-CDI rate was measured to determine if there were differences amongst the number at baseline, during the EMR intervention, and during the EMR with phone call intervention.

Procedures. This project was approved by the Institutional Review Boards at the University of Kansas School of Medicine and Ascension Via Christi Hospital. On March 30 and 31, 2017, the *C. difficile* testing algorithm was introduced to providers at AVCH internal medicine staff meetings. This algorithm required three or more liquid stools within a 24-hour period, no diarrhea causing drugs (e.g., laxatives, suppositories) within 48 hours, no other known causes of diarrhea (e.g., Crohn's disease, Roux-en-Y), and an indication of an infection (e.g., abdominal pain, fever, leukocytosis). Alternatively, if a provider suspected toxic megacolon in a patient not producing stool but has other signs of *C. difficile* infection, testing was recommended. Although not stated in the algorithm, this exception was understood by providers.

Regarding the algorithm's requirement of three liquid stools within 24 hours, tests ordered for patients who could produce a stool sample upon admission were considered to have fulfilled this requirement as this waiting to observe three liquid stools could delay diagnosis and endanger participants.

On October 1, 2018, the EMR-based decision support system was added to supplement the testing algorithm and was designed to notify providers if they were attempting to order a *C. difficile* test that did not adhere to the testing algorithm. Data abstraction did not include charts in April 2017 or October 2018 to allow providers a month to learn the testing algorithm and to ensure there were no glitches in the EMR-based decision support system.

Beginning November 19, 2019, a dedicated registered nurse called the providers caring for patients with an ordered *C. difficile* test with delayed collection, as the preferred population for *C. difficile* testing was patients with at least three unformed stools in a 24-hour period.[12] If the test did not adhere to the protocol or the patient was no longer symptomatic, the provider was advised to discontinue the test. If the provider deemed that the test was needed, regardless of algorithm adherence, prompt specimen collection was recommended, as a further delay of collection could lead to misclassification of community onset CDI as HO-CDI.

Statistical Analysis. Data were abstracted from the EMR into REDCap® for management.[13] SAS 9.4 (SAS/STAT Inst., Cary NC)

was used for all data analyses. The socio-demographic characteristics were summarized using descriptive statistics. Means and standard deviations (or medians and interquartile ranges) were reported for continuous variables; counts and percentages were reported for categorical variables. Likelihood ratio chi-square and Fisher's exact tests were used to test the association and agreement for the categorical and nominal variables. Further, the Cochran-Mantel-Haenszel test was used to reveal associations between categorical and nominal variables after controlling for the strata variables in the multiway tables. The nonparametric one-way Kruskal-Wallis test was performed to test the difference between groups for age and length of stay. The Dwass, Steel, Critchlow-Fligner (DSCF) test was used for multiple comparisons. All statistical tests at $p \leq 0.05$ were considered significant.

RESULTS

A total of 311 patient charts with *C. difficile* tests were reviewed. For all time periods, nearly one-third (31%; n = 96) of these tests were discontinued, and 5% (n = 14) were rejected by the lab due to the stool sample being solid. This resulted in data from 201 patients, the final sample size.

On average, patients were 64 years of age (SD 16.3). Most (61%; n = 123) were female, and 87% (n = 174) had healthcare coverage. The average length of stay was 10 days.

Algorithm Criteria. The proportion of tests that met algorithm criteria for diarrhea ranged from 81% (n = 81) at baseline to 84% (n = 80; p = 0.345) with the EMR. The proportion of tests that did not meet algorithm criteria for stool softeners, laxatives, lactulose, or enemas decreased from 19% (n = 19) at baseline to 9% (n = 9; p = 0.045) with the EMR. In addition, the proportion of tests that did not meet algorithm criteria for alternate causes of diarrhea decreased from 28% (n = 28) at baseline to 14% (n = 13; p = 0.011) with the EMR. Finally, the proportion of tests that met all algorithm criteria increased from 34% (n = 34) at baseline to 52% (n = 49; p = 0.010) with the EMR.

Tests with Delayed Sample Collection. Of all the charts reviewed during all study time periods, 100 had delayed sample collection. In general, there was no difference between tests with delayed sample collection (48%; n = 16) and those that did not have delayed sample collection (44%; n = 78; p = 0.63) when meeting algorithm requirements. During the EMR with phone calls period, of the 107 tests with delayed sample collection, phone calls were made for 44% (n = 47). More tests were discontinued (87%; n = 39) compared to baseline (54%; n = 15) and EMR (54%; n = 15, p = 0.003).

HO-CDI Rate. The EMR and EMR with phone call interventions were associated with a decrease in the HO-CDI rate. The HO-CDI rate ranged from 8.5 cases per 10,000 patient-days at baseline, to 7.9 during EMR, to 4.0 during EMR with phone calls (p = 0.007).

30-Day Readmissions. Among all hospitalized patients diagnosed with CDI, there was no significant change associated with the EMR or the EMR with phone call interventions with regards to 30-day readmissions. CDI readmissions ranged from 20% (n = 42) at baseline, to 18% (n = 35) during EMR, to 13% (n = 6) during EMR with phone calls (p = 0.547).

Table 1. Algorithm adherence criteria and outcomes at baseline and with the EMR.*

Adherence Criteria and Outcomes	Baseline % (n)	EMR % (n)	p Value (one-sided)
3 stools in 24 hours	81% (81)	84% (80)	0.345
Acute kidney injury	37% (37)	27% (26)	0.099
Algorithm fidelity	34% (34)	52% (49)	0.010
Antibiotics within 30 days	65% (65)	44% (42)	0.003
Chemo within 30 days	19% (19)	15% (14)	0.274
Drugs that cause diarrhea (e.g., laxatives)	19% (19)	9% (9)	0.045
Hemodialysis	9% (9)	4% (4)	0.146
Other causes of diarrhea	28% (28)	14% (13)	0.011
Positive test outside 30 days	11% (11)	7% (7)	0.266
Positive test within 30 days	4% (4)	1% (1)	0.200
Proton pump inhibitor usage	35% (35)	35% (33)	0.545
Signs of infection	66% (66)	67% (67)	0.480
Test collected after 72 hours	33% (33)	29% (28)	0.354
Toxic megacolon	3% (3)	2% (2)	0.693
Vasopressor usage (per event)	15% (15)	8% (8)	0.114

*Shaded rows are statistically significant.

DISCUSSION

This study examined the utility of interventions to reduce unnecessary *C. difficile* testing at AVCH in Wichita, KS. The EMR-based decision support system was associated with improved provider adherence to the testing algorithm than at baseline as well as a decrease in the HO-CDI rate. This aligned with similar studies which have decreased HO-CDI rates and increased adherence to hospital *C. difficile* testing algorithms.[7,9,10,14] Neither EMR or the EMR with phone call interventions were associated with an increase in 30-day hospital readmissions, vasopressor usage, or toxic megacolon, suggesting that diagnosis or treatment of CDI was not delayed. However, the current study suggested that there were still patients receiving treatment for a positive *C. difficile* test that was ordered, but not in compliance with the algorithm, indicating the need for further intervention. Additional interventions should include options in the EMR for providers to report why they were non-adherent to testing so these reasons can be targeted better or included in testing algorithms.

The EMR with phone calls intervention resulted in an increased percentage of discontinued *C. difficile* tests compared to baseline and EMR as well as a decrease in the overall HO-CDI rate. The further decrease in HO-CDI was expected as provider phone calls were a stronger intervention than an EMR prompt. Although the phone call intervention targeted a relatively small group of tests, the total effect of the phone calls was greater due to the prospective benefits of educating providers. In other words, providers who received phone calls likely followed the algorithm more closely with future patients. It was expected that the need for the phone calls will decrease as providers are more

educated about *C. difficile* testing. However, this study was limited by the relatively short study period of EMR with phone calls as compared to the other time periods. Further studies should explore this intervention for longer periods of time to accumulate more data on the effects of such phone calls. Similarly, more than one designated person making phone calls to providers could improve fidelity to the interventions. An improved intervention might require the provider to reorder the test after 24 hours had passed without sample collection. This may decrease testing further by causing providers to reevaluate the patient's clinical condition.

Limitations. An important study limitation was that the EMR with phone calls intervention was not evaluated during all seasons, as *C. difficile* infections tended to have the highest incidence in the spring and lowest in the fall.[15] To account for the limitations, future studies must examine these and other interventions for longer periods of time to reduce C. difficile testing that is not indicated clinically.

CONCLUSIONS

This study suggested that an EMR-based decision support system, combined with phone calls to providers, can reduce *C. difficile* testing that is not indicated clinically. This intervention was associated in a decrease in the HO-CDI rate.

REFERENCES

[1] Noren T. Clostridium difficile and the disease it causes. Methods Mol Biol 2010; 646:9-35. PMID: 20597000.
[2] Magill SS, Edwards JR, Bamberg W, et al. Multistate point-prevalence survey of health care-associated infections. N Engl J Med 2014; 370(13):1198-1208. PMID: 24670166.
[3] Zhang S, Palazuelos-Munoz S, Balsells EM, Nair H, Chit A, Kyaw MH. Cost of hospital management of Clostridium difficile infection in United States-a meta-analysis and modelling study. BMC Infect Dis 2016; 16(1):447. PMID: 27562241.
[4] Rock C, Pana Z, Leekha S, et al. National Healthcare Safety Network laboratory-identified Clostridium difficile event reporting: A need for diagnostic stewardship. Am J Infect Control 2018; 46(4):456-458. PMID: 29305285.
[5] Centers for Medicare & Medicaid Services. Hospital-Acquired Condition Reduction Program. https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/ AcuteInpatientPPS/HAC-Reduction-Program. 2021. Accessed December 11, 2021.
[6] Dubberke ER, Burnham CA. Diagnosis of clostridium difficile infection: Treat the Patient, not the test. JAMA Intern Med 2015; 175(11):1801-1802. PMID: 26348248.
[7] Fleming MS, Hess O, Albert HL, et al. Test stewardship, frequency and fidelity: Impact on reported hospital-onset Clostridioides difficile. Infect Control Hosp Epidemiol 2019; 40(6):710-712. PMID: 31006411.
[8] Johnson S, Homann SR, Bettin KM, et al. Treatment of asymptomatic Clostridium difficile carriers (fecal excretors) with vancomycin or metronidazole. A randomized, placebo-controlled trial. Ann Intern Med 1992; 117(4):297-302. PMID: 1322075.
[9] Kavazovic A, Fleming MS, Knowlson S, et al. Clostridioides difficile nurse driven protocol: A cautionary tale. Am J Infect Control 2020; 48(1):108-111. PMID: 31358422.
[10] Baghdadi J, Ganz DA, Chumpia M, Chang ET, de Peralta SS. Holding firm: Use of clinical correlation to improve Clostridioides difficile testing. Am J Infect Control 2020; 48(9): 1104-1107. PMID: 31862165.
[11] Madden GR, German Mesner I, Cox HL, et al. Reduced clostridium difficile tests and laboratory-identified events with a computerized clinical decision support tool and financial incentive. Infect Control Hosp Epidemiol 2018; 39(6):737-740. PMID: 29644943.
[12] McDonald LC, Gerding DN, Johnson S, et al. Clinical practice guidelines for clostridium difficile infection in adults and children: 2017 update by the Infectious Diseases Society of America (IDSA) and Society for Healthcare Epidemiology of America (SHEA). Clin Infect Dis 2018; 66(7):987-994. PMID: 29562266.
[13] Harris PA TR, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap) – A metadata-driven methodology and workflow process for providing translational research informatics support. J Biomed Inform 2009; 42(2):377-381. PMID: 18929686.
[14] White DR, Hamilton KW, Pegues DA, Hanish A, Umscheid CA. The impact of a computerized clinical decision support tool on inappropriate Clostridium difficile testing. Infect Control Hosp Epidemiol 2017; 38(10):1204-1208. PMID: 28760168.
[15] Furuya-Kanamori L, McKenzie SJ, Yakob L, et al. Clostridium difficile infection seasonality: patterns across hemispheres and continents - a systematic review. PLoS One 2015; 10(3):e0120730. PMID: 25775463.

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