American Journal of Infection Control 51 (2023) 1085–1088

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Major Article

Does clinician-initiated *Clostridioides difficile* testing improve outcomes of patients with *Clostridioides Difficile* infection?

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Key Words:
Hospital-acquired infection control
Hospital policy change
Hospital policies
Ordering time
Stool samples

A B S T R A C T

Background: Clostridioides difficile (*C. difficile*) is a common hospital-acquired infection which can lead to major implications for patients and our health care system. In this study, we examine a policy change at a single-site Veterans Affairs Healthcare system that allowed bedside nurses to order *C. difficile* testing in addition to physicians on the time to obtain test results and initiate treatment.

Methods: The time to receive results and initiate treatment were analyzed before and after the policy change, and between physicians and nurses using descriptive statistics and paired student *t*-tests. Variables associated with lower ordering times were also analyzed using logistic regression while adjusting for patient admission location and length of inpatient hospital stay.

Results: The difference in time to obtain the result both before and after the policy change and between ordering provider type were both statistically significant ($P < .05$). In unadjusted models, nurses were associated with faster test results compared to physicians (OR (95% CI) 1.72 (1.45-2.05).

Conclusions: Allowing bedside nurses more autonomy to order the stool sample significantly decreased the amount of time to receive the results, potentially decreasing the risk of additional infections among patients and decreasing the economic burden on the hospital.

Clostridioides difficile (*C. difficile*) is a gram-positive, toxin-forming, anaerobic bacillus, which is widely distributed in the intestinal tract of living organisms.[1–3] The pathogenic properties are produced by toxins released into the gastrointestinal tract, in conjunction with a loss of balance within the gastrointestinal flora.[4] *C. difficile* produces 2 protein exotoxins, toxin A and toxin B, which cause colonic mucosal injury. These toxins are not only responsible for active infection but are also targeted for testing purposes of *C. difficile* infection (CDI) versus colonic colonization. The clinical picture and presentation are wildly diverse; however, it often includes varying degrees of diarrhea and malodorous stool.[5] Testing is typically achieved by testing for the B toxin in the stool, historically via the *C. difficile* toxin enzyme immunoassay (EIA assay) but more recently with the more sensitive *C. difficile* B toxin polymerase chain reaction (PCR).[6] Antibiotic treatment (vancomycin, metronidazole, and fidaxomicin) and contact precautions are initiated following a confirmed positive.[7] Although the overall severity and frequency of CDI has decreased in the past decade in the United States, the adjusted numbers of first recurrences and in-hospital mortality have not had a significant change and it remains one of the most common hospital-acquired infections.[8-10]

CDI has previously been associated with a 2.5-fold increase in 30-day mortality, even in the absence of an outbreak within the healthcare facility.[11] Additionally, it holds an economic burden within our healthcare system as estimated annual CDI-related costs to the U.S. is 6.3 billion dollars.[12–14] Early detection, contact precaution, and antibiotic treatment greatly decrease the rate of morbidity and mortality and can prevent further spread to other patients, overall decreasing the clinical and economic impact.[12] Studies of patients with hospital-acquired CDI estimate that the infected patient stays hospitalized, an average between 3 and 26 days longer than patients without CDI, further worsening the economic and patient burden.[15] Moreover, length

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Conflicts of interest: None to report.

https://doi.org/10.1016/j.ajic.2023.02.017
0196-6553/Published by Elsevier Inc. on behalf of Association for Professionals in Infection Control and Epidemiology, Inc.

of hospital stay was further demonstrated to be prolonged in those with severe disease at the time of diagnosis, a factor that could have been potentially alleviated had there been earlier detection. CDI has also been associated with lower quality of life in those affected.[16] Given the implications of CDI on both a hospital, and patient level, incentives exist for improving approaches to prevention of spread and treatment in the clinical environment.[13]

One approach to improve the prevention and treatment of CDI might be to encourage nurse autonomy when ordering stool samples. However, published studies to support this strategy are lacking. At a single-site Veterans Affairs (VA) Healthcare System (Fargo, ND), a policy change was suggested by the Fargo VA Infectious Disease physician, drafted by nurse managers, approved by facility leadership, and enacted to encourage nurse autonomy when ordering stool samples. Prior to this policy change, only physicians (physicians, physician's assistants, clinical pharmacists, or certified nurse practitioners) could order stool tests, leading to delays in acquiring test results. After the policy change, nurses were also allowed to order the stool samples for new patients displaying symptoms of CDI. In this study, we tested the effectiveness of this policy change by comparing the frequency of tests being ordered, the time to obtain the test results, and the time to initiate treatment for positive *C. difficile* tests before and after the policy change. Additionally, we compared these same parameters between the ordering clinician type (nurses vs. physicians) after the policy change. We hypothesized that the time needed to obtain the test results and initiate treatment for *C. difficile* positive patients significantly decreased after the policy change was enacted.

METHODS

Policy change

In May 2016, the Fargo VA HCS implemented the new policy to encourage nursing staff to make more informed decisions about their patients and improve patient outcomes. With this policy, nurses (RNs and LPNs) could independently order *C. difficile* stool testing without the requirement for a physician's electronic signature, expediting the testing of stool *C. difficile* toxin gene in hospitalized patients with diarrhea. A copy of this policy can be found in Appendix 1.

Data sources

Patient records were pulled from the VA's Electronic Health Records (EHR) for all Fargo VA patients who were admitted as an inpatient to the main floor (medical/surgical inpatient main), transitional care unit (TCU), or the intensive care unit (ICU). *C. difficile* Toxin B Gene PCR was used per laboratory protocol. The Bristol stool scale was used to determine patients with active diarrhea in need of testing for CDI. The Bristol stool scale is used to define stool that classifies as "diarrhea" by the European Society for Clinical Microbiology and Infection for CDI.[18] Patients with a sample with a Bristol Stool Scale score 6 or 7 were included in this study. Exclusion criteria include Bristol Scale <6, *C. difficile* studies not tested within the Fargo VA laboratory, *C. difficile* tests ordered as an outpatient, and *C. difficile* testing submitted before admission. Treatment initiation was defined as antibiotic treatment with either vancomycin, metronidazole, or fidaxomicin. Additionally, all other treatment modalities were excluded from this study.

Variables

We compared the total number of tests ordered during the time period before and after the policy change as well as the number of positive and negative tests. The 2 timetables looked at were before the policy change (September 1, 2012-April 30, 2016 [44 months]) and after the policy change (May 1, 2016 to March 1, 2021 [59 months]). Patient-level variables included inpatient location (main floor, TCU, or ICU) and length of patient's inpatient hospital stay (0-2, 3-4, 5-6, >6 days). The primary outcomes were "time to obtain *C. difficile* PCR test results" and "time to initiate treatment after positive test result" before and after the policy change. Lastly, we analyzed whether these were differences between physicians and nurses time to obtain test results or initiate treatment after the policy change.

Statistical analysis

Data were analyzed using Stata 16 (StataCorp. 2017. College Station, TX: StataCorp LLC). Descriptive statistics and Wilcoxon rank-sum test were used to analyze pre- and post-intervention rates. The Wilcoxon rank-sum test is a useful for the comparison of 2 groups of nonparametric data equivalent to the 2-sample *t* test to compare 2 independent groups.[19] Unadjusted and adjusted logistic regression models were also applied to measure the association between the binary outcome of "less than 2 hours to obtain *C. difficile* Toxin B Gene PCR test result" (yes/no) and the covariates of policy change [after policy change, yes/no]), the ordering healthcare provider type as a categorical variable (nurses vs. physicians [ref]), and patient admission type as a categorical variable (inpatient main [ref], TCU, or ICU).

RESULTS

After the policy change, there were a relatively even proportion of nurses and physicians ordering the stool PCR labs (51.1% vs 48.9%,

Table 1
Descriptive statistics of type of stool tests ordered, results, time between test order and results, time taken to initiate treatment, patient admission type, and average length of hospital stay before the policy change (September 1, 2012–April 30, 2016) and after the policy change (May 1, 2016-March 1, 2021)

	Prior to policy change	After policy change
Number of stool tests ordered per total admissions, N (%)	672 (7.3%)	1,976 (19.8%)
Ordering Healthcare Provider		
Nurses	2 (0.3)	1,010 (51.1)
Physicians	670 (99.7)	966 (48.9)
Time between test order and result (hours), mean (sd)	2.2 (1.3)	1.3 (0.7)
Positive test result, N (%)	94 (13.9)	227 (11.5)
Patient admission type, N (%)		
Inpatient main	504 (75.0)	1,608 (81.4)
Transitional care unit	90 (13.4)	167 (8.5)
Intensive care unit	78 (11.6)	201 (10.2)
Average length of inpatient hospital stay (days), N (%)		
0-2 d	245 (36.5)	764 (38.7)
3-4 d	146 (21.7)	434 (21.9)
5-6 d	72 (10.7)	210 (10.6)
>6 d	208 (30.9)	568 (28.7)

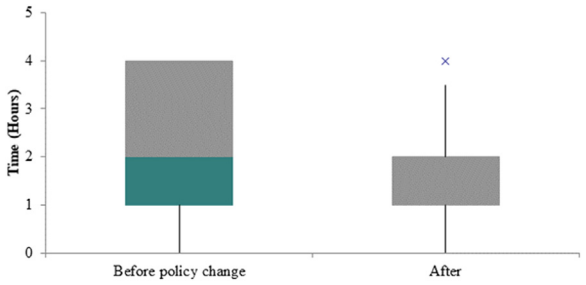

Fig 1. Boxplot of time (hours) between when the stool sample order was placed and the reported test result before and after the policy change. The median and variance of the time from test order to test result in hours before and after the policy change is demonstrated above. Before the policy change, the variance in hours was wider than after the policy change. (1.9 hours vs 0.7 hours respectively). Additionally, before the policy change, the interquartile are shown was variation from the mean. After the policy change, "x" is an outlier and there is no difference in the mean from the upper quartiles given the small degree of variation in the data set.

respectively; Table 1). The percent of positive and negative test results before and after the policy change was relatively unaffected. (13.9% vs. 11.5%, respectively; Table 1). The average difference in time to obtain the test result after the PCR lab order was statistically significant before versus after the policy change (mean [sd]; 2.1 (1.3) vs 1.3 (0.7) hours; $P < .01$; Fig. 1). Additionally, time to obtain the test result after the PCR lab order between nurses and physicians once the policy change was in place was also statistically significant (mean [sd] 1.2(0.7) vs 1.3(0.7) hours; $P = .02$). There was no significant difference in time to initiate treatment before and after the policy change (1.7 vs 1.7 hours; $P = .38$).

In both unadjusted and adjusted logistic regression models, we found that stool samples ordered before the policy change had lower odds of obtaining a test result within 2 hours (OR (95% CI) 0.42 (0.33-0.52); Table 2). In the unadjusted model, nurses were statistically more likely to have the stool results within 2 hours; however, when adjusting for patient admission location and time period, this was nonsignificant (OR [95% CI] 1.72 (1.45-2.05) vs 1.14 (0.94-1.39), respectively; Table 2). Finally, a stool sample was statistically more likely to have a positive *C. difficile* test result if the patient was admitted to the transitional care unit (TCU) (OR [95% CI] 1.22 (1.19-1.24), or if they were admitted for >6 days (OR [95% CI] 1.53 (1.37-1.71); Appendix II).

DISCUSSION

Although rates of CDI have declined in the last decade, CDI continues to be prevalent in U.S. health care facilities. This is despite numerous implementation strategies to address the prevention of *C. difficile* such as early contact precaution, improved hand-hygiene initiatives, rapid stool testing, and appropriate surface cleaning solutions.[6,10,20] The role of time to order testing and physician acquisition of symptomology could reduce the potential spread and morbidity for the patient through earlier initiation of treatment and the placing of contact precautions.

The Fargo VA Health Care System implemented one such potential strategy by encouraging bedside nurses to swiftly identify symptomology and order *C. difficile* testing. This policy change led to statistically significant decreases in the amount of time between the ordering of the test to obtaining the result. By allowing nurses to immediately collect the stool from the patient, ordering the lab test, and delivering the sample to the laboratory, the time to receive the result was greatly expedited (Table 1, 1.3 vs 0.7 hours). This was also found to be clinically relevant, as the VA nurses at this facility subjectively reported that they were then able to place contact precautions hours earlier than they previously would have to prevent the spread of CDI to other patients on the floor. Additionally, there was a significant difference in the amount of time to order CDI testing between nurses and physicians during the later period after the policy change (1.2 vs 1.3 hours, respectively). This finding was unsurprising as there was a larger population of nurses vs physicians at this facility, and we do not have reason to believe that this is clinically meaningful. With the expedited processing time of the stool samples, nurses at this facility have continued to order the stool tests independent of the clinicians.

In theory, decreasing time to test result could lead to earlier treatment initiation, time to contact precaution, and even discharge. However, our study found no statistically significant difference in time to initiate treatment after the policy change, which would most likely be because although nurses could now order the tests, they did not have the ability to order antibiotics. Therefore, despite the tests returning faster with nurses ordering the test, the process of notifying physicians to initiating antibiotics was unchanged. The laboratory was still required to report the test result to the physician, even if the test was ordered by nursing staff.

As for positivity of CDI before and after the policy change, we found that patients were more likely to have a positive stool sample if they were admitted to the long-term care facility or had been hospitalized for 6 or more days. This result supports the theory that *C. difficile* risk is directly correlated to hospital length of stay and comorbidities, which those residing in a long-term care facility are more likely to have.[21] Physicians and nurses should have a higher index of suspicion for ordering stool PCR tests in symptomatic patients who have been hospitalized or in a care facility for >6 days. Given the rate of positivity was similar before and after the policy change (Table 1, 13.9% vs 11.5%), we believe that allowing nursing staff to order stool samples does not lead to increased unnecessary laboratory resource use or financial burden to the hospital.

Table 2
Results from logistic regression model predicting less than 2 hours between stool sample order and test result

	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Time Period		
Prior to policy change (September 2021-April 2016)	**0.36 (0.30-0.42)**	**0.42 (0.33-0.52)**
After policy change (Mary 2016-March 2021)	Ref	Ref
Ordering health care provider		
Nurses	**1.72 (1.45-2.05)**	1.14 (0.94-1.39)
Physicians	Ref	Ref
Patient admission type		
Inpatient Main	Ref	Ref
Transitional Care Unit	1.04 (0.79-1.38)	1.19 (.089-1.58)
Intensive Care Unit	0.80 (0.62-1.04)	0.84 (0.65-1.10)

C Diff, Clostridioides difficile; CI, confidence intervals; *EIA*, enzyme immunoassay; *PCR*, polymerase chain reaction; *OR*, odds ratio. Statistically significant values with *P*-value <.05 are bolded. Ref= reference categorical variable against odds ratio.

Although adding nurses to the dynamic symptom identification and the diagnostic team is suggested to be beneficial in this study, it should be used in tandem with other strategies to optimize infection control in hospitalized patients. Because the study was a retrospective chart review, there are limitations. Firstly, we were unable to quantitative data on the time to initiate contact precautions. Future studies would benefit by collecting this, as well as data on readmission rates and mortality in patients after introducing a policy change such as this. Additionally, it is difficult to compare this study to others as there is no other published studies with a similar strategy for implementing nurse autonomy for ordering stool sample tests to our knowledge. In conclusion, our results suggest there is a benefit to encouraging nurses to order *C.difficile* testing following appropriate training for symptom identification to decrease spreading and decrease overall CDI rates. VA nurses now have greater autonomy in ordering lab tests and expediting result processing. Other hospital facilities could benefit by considering a similar policy to implement nurse-driven *C.difficile* stool test orders, in addition to other CDI rate-decreasing initiatives.

DISCLOSURE

These findings are the result of work supported with resources and use of facilities at the Fargo Veterans' Affairs Health Care System. The contents do not represent the views of the US Department of Veterans' Affairs.

SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found in the online version at https://doi.org/10.1016/j.ajic.2023.02.017.

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