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Concise Communication

Utilizing a real-time discussion approach to improve the appropriateness of *Clostridioides difficile* testing and the potential unintended consequences of this strategy

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Abstract

We report electronic medical record interventions to reduce *Clostridioides difficile* testing risk 'alert fatigue.' We used a behavioral approach to diagnostic stewardship and observed a decrease in the number of tests ordered of ~4.5 per month ($P < .0001$). Although the number of inappropriate tests decreased during the study period, delayed testing increased.

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Effective strategies to improve appropriate ordering of *C. difficile* infection (CDI) testing as a means of diagnostic stewardship remain elusive. Electronic medical record (EMR)–based solutions, such as hard and soft stops, have been associated with reductions in the number of tests sent, but they may not be sustainable due to 'alert fatigue.'[1] Although these measures are effective, fewer studies address the potential for undertesting, missed diagnoses, and the implications for patient safety or clusters of transmission.[2,3] This aspect is important because computer-based solutions rely on criteria that take into account the number of stools and laxative use, which are derived from weak evidence,[4–6] and they do not take the whole clinical picture into account.

We previously identified the main drivers of inappropriate CDI testing at our facility. These included conflicting definitions and inaccurate documentation of diarrhea in the EMR, as well as clinician-perceived risk of CDI, which was driven by length of stay rather than knowledge or lack thereof regarding laxative use.[4] Inappropriate documentation of diarrhea therefore poses the risk of inappropriate alerts, and these alerts neither utilize nor assuage the clinician's motivation to avoid patient risk.[7] We hypothesized that an EMR-based 'alert' approach to diagnostic stewardship may not be an effective and sustainable solution for our institution.

We sought to adopt a more behavioral approach to diagnostic stewardship while monitoring the potential unintended consequences to patients that may be caused by undertesting.

Methods

The study was conducted in 2 adult, tertiary-care hospitals in the Midwestern United States. The hospitals have 1,100 licensed beds and serve 36,000 patients annually.

Drivers of inappropriate testing

The contributors to inappropriate testing were identified in a previous study[7] and through an internal retrospective review of our CDI cases from 2017.

1. *Inconsistent definition of diarrhea*
   We identified 18 different ways stool could be documented in the EMR. We also found discrepancies between the stool frequencies documented in the EMR and what the patient or nurse reported to the ordering physician.[7] Such discrepancies were noted in nearly half of the instances of inappropriate testing, which indicates a potential for overtesting.

2. *Patient perceived as high risk by clinicians*
   The perception of high risk relates to the knowledge, attitudes, and beliefs of clinicians regarding CDI diagnosis. The patient's length of stay and prior antibiotic use were the most commonly cited reasons for the perception of high risk, and they were the reasons for testing in 30% of interviews.[7] Thus, any solution needs to consider clinicians' aversion to risk taking when it comes to patient care.

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3. *Lack of involvement of the nursing team in diagnostic stewardship efforts*
   Based on an internal review of the hospital-onset CDI cases from January 2018 to April 2018, we identified 10 (20%) orders for CDI testing that were nurse-driven orders. Thus, we recognized that our diagnostic stewardship effort needed to involve the nursing team.

Development of solutions

A team convened to develop a bundled approach to improve diagnostic stewardship based on the listed contributors. The team developed a critical thinking tool (Supplementary Fig. S1 online) that helped reliably define diarrhea and what constitutes an appropriate testing algorithm (Supplementary Fig. S2 online) with the help and feedback of front-line clinicians (nurses, physicians, patient care assistants (PCA), pharmacists, and dieticians). The algorithm was vetted with direct care staff and went through several iterations based on their feedback; it included the following:

1. *Solution 1: Utilize the Bristol stool scale to improve reliability of diarrhea description*.
   We developed a nurse focus group to investigate the interrater reliability of the Bristol stool scale compared with our EMR documentation of diarrhea.[8] We found 100% concordance in answers with Bristol stool scaled compared with low concordance in answers pertaining to stool description in the current EMR settings. Therefore, we included the Bristol stool scale as a standardized scale for describing diarrhea. The algorithm recommended CDI testing if 3 or more Bristol class 6 or 7 stools were charted in a 24-hour period. Even though we could not incorporate the Bristol stool scale within the EMR due to technical limitations, our tool transformed the conversation about diarrhea between clinicians to reflect the Bristol scale. The critical thinking tool was distributed to all nursing staff as flyers and/or pocket cards depending on staff preference.

2. *Solution 2: Engage clinicians in real-time conversations about testing*
   This process occurred through face-to-face discussions on CDI cases or by phone interviews prompted by the test order.[7] These discussions led to creation of a critical thinking tool with a 'termination plan' that took into account factors associated with high risk of infection, such as those with persistent diarrhea after 24 hours of stopping laxatives and those with signs and symptoms of colitis and toxic megacolon.

3. *Solution 3: Engage dieticians, PCAs, and nurses in diagnostic stewardship*
   Identification of dieticians, nurses, and PCA champions for diagnostic stewardship was a core component of our implementation process. The critical thinking tool was codeveloped with them, and their feedback was routinely incorporated into the final product.

Study periods

Assessments of barriers and creation of solutions occurred between January 2018 and April 2018, the baseline period. The implementation period of the tools and algorithms took place between May 2018 and December 2018, and the sustainment period was between January 2019 and May 2019.

Implementation phase

The critical thinking tool was adapted to all units depending on their preference; some units preferred flyers and others preferred pocket cards. The algorithm was also discussed in hospital-wide clinician didactic sessions and through videos disseminated to the entire house staff pool. Intermittent feedback about the algorithm was purposefully sought from clinicians during the development process and also after implementation. After implementation, feedback from clinicians about restriction of testing by nurses or PCAs (when test was ordered and algorithm criteria were not met) was resolved immediately through direct communication between the department of infection prevention (for the most part the medical director) and the clinicians. At the same time, feedback regarding testing appropriateness was given to clinicians informally over the phone and more formally during team huddles.

Study definitions

Testing was considered inappropriate if the patient had <3 stools in 24 hours in the absence of signs and symptoms of colitis or toxic megacolon. Testing was considered appropriate if a patient had ≥3 Bristol class 6 or 7 stools in 24 hours in the presence of signs and symptoms of colitis (ie, unexplained abdominal pain, unexplained fever, or unexplained leukocytosis). Delayed testing was defined as CDI-compatible diarrhea based on the algorithm if the test was ordered >24 hours after they met the criteria for testing.

Process and outcome measures

The primary outcome was the number of CDI tests performed. Secondary outcomes were appropriateness of CDI testing, as well as unintended consequences of our intervention, which included delayed testing and the development of toxic megacolon. A team of 3 infectious diseases doctors and 5 infection preventionists reviewed the EMRs of all hospital-onset CDI cases and determined appropriateness of testing based on the definitions in the previous section.

Statistical methods

To assess the change in the number of tests ordered over time, we fit a linear regression spline with a break point at the January 2018 time point to indicate the start of the implementation period.

Results

During the prestudy period, there was no significant change in number of tests ordered over time, and the average number of tests ordered per month was 194.2. During the study periods, we detected a significant decrease in the number of tests ordered of ~4.5 per month from January 2018 through May 2019 ($P < .0001$) (Fig. 1).

The number of inappropriate tests decreased from 54.4% in the baseline period to 25% in the sustainment period. The number of delayed testing decreased from 12.3% in the baseline period to 1.4% in the implementation period and then increased to 21.9% in the sustainment period (Table 1). No patients developed toxic megacolon as a result of delayed testing during the 3 study periods.

Discussion

The decision to test for CDI is very complex and is based on nuanced and individualized assessments that depend on the clinician–patient interaction. Here, we show that utilizing a behavioral

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Table 1. Inappropriate and Delayed Testing

Inappropriate Orders From January 2018 Through June 2019 for Hospital-Onset Cases of *C. difficile*, No./Total (%)			
Hospital	Baseline	Implementation	Sustainment
1	19/33 (57.6)	9/26 (34.6)	2/25 (8)
2	12/24 (50)	24/45 (53.3)	14/39 (35.9)
Total	31/57 (54.4)	33/71 (46.5)	16/64 (25)
No. of delayed orders from January 2018 through June 2019 Hospital-Onset Cases of *C. difficile*, No./Total (%)			
Hospital	Baseline	Implementation	Sustainment
1	5/33 (15.2)	1/26 (3.8)	7/25 (28)
2	1/24 (4.2)	0/45 (0)	7/39 (17.9)
Total	7/57 (12.3)	1/71 (1.4)	14/64 (21.9)

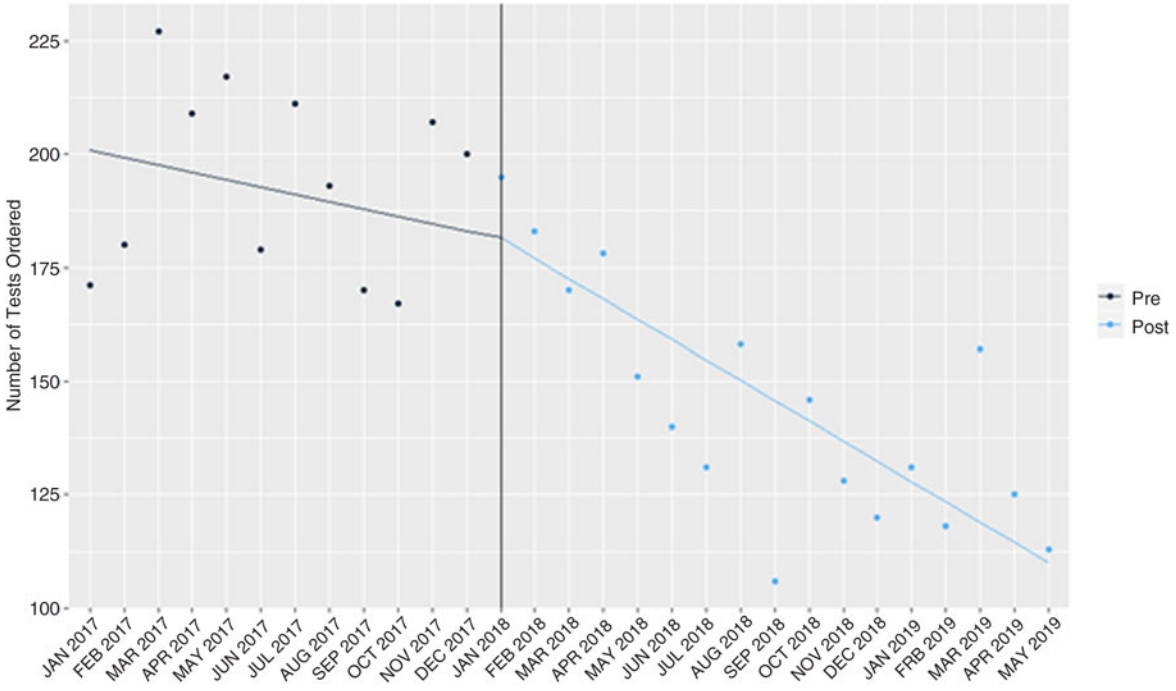

Fig. 1. Reduction in CDI testing over time. The y-axis represents time and the x-axis represents the number of tests. The 'pre' period represents the time-frame prior to the start of the study, where no intervention for CDI diagnostic stewardship was implemented. The 'post' period represents the entire duration of the study (the 3 study periods).

approach to CDI diagnostic stewardship is effective, and we describe potential unintended consequences.

In this study, we attempted to bypass some of the failure modes that are common in quality improvement implementation projects, such as failing to confirm and understand the problem deeply upfront, failing to engage key stakeholders, and performing 'dirty' rather than 'quick' implementation cycles.[9] Instead, we thoroughly examined and defined the problem ahead of time, engaged stakeholders, a performed root-cause analysis, and sought to address each identified barrier individually. Our framework was based on the agile implementation model, which we have successfully utilized to improve hospital-acquired infections.[10,11]

Quality improvement projects can fail due to technical or 'adaptive' challenges, and the latter have more to do with attitudes and beliefs rather than knowledge.[12] In this study, we show a consistent and sustainable reduction in CDI testing that was brought about by changes in clinician behavior that was not tied to soft or hard EMR-based interventions. Our intervention engaged clinicians in the 'why' and the need for change, and it addressed the root causes of clinician prescribing, mainly loss aversion (avoiding loss at any cost, in this case missing a CDI) and risk perception (perception that certain patients are at high risk of CDI). Our intervention changed the culture around CDI testing from a unilateral (nurse driven, or clinician driven) to more of a communication

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about patient symptoms, which was captured informally and reflected by an increase in discussion about testing indications between members of the clinical team. This process highlights the complexity of diagnostic stewardship and the need for in-depth interdisciplinary discussions that are not always resolved with computer alerts, which do not take the whole clinical picture into account. The importance of this process is further demonstrated in the fact that hospital 2 had a slower response to testing reduction than hospital 1; we hypothesize that this is related to greater clinician engagement upfront in hospital 1, followed by hospital 2.

In our study, we continuously monitored for unintended consequences of our intervention on patient safety and organizational pressure. Although no cases of toxic megacolon or death were related to CDI testing, we identified a new pattern of delayed testing that was not prevalent prior to the intervention. We hypothesize that this is a consequence of a shift in the culture from reflexive testing of 'diarrhea' to a more thoughtful evaluation that resulted in reluctance to test. Although no obvious patient harm was noted, toxic megacolon is a rare complication (0.4%–3%), and its absence during a certain study period does not automatically imply safety.[13] Additionally, there is a theoretical risk for increased transmission of *C. difficile* with delayed testing because untreated symptomatic patients carry the highest risk for transmission.[14]

This study has several limitations. We did not compare the effectiveness of our approach with EMR-based approach to diagnostic stewardship. Furthermore, real-time feedback about testing appropriateness was being given to clinicians as a form of audit and feedback (through phone calls) when issues were raised by bedside staff, but this was not done on every test order because it was not logistically feasible. In this study, additional confounding could have been caused by a change in CDI testing in June 2018, from PCR to multitest algorithms. The results of CDI tests were displayed as positive, negative, or likely colonized (for PCR positive but Toxin-negative results). Although this display of results may have served as an audit and feedback tool in-and-of itself, the reduction in testing started prior to implementation of this change.

In conclusion, we have shown that that behavioral strategies to reduce CDI are effective and sustainable. We believe that interventions that focus only on diagnostic stewardship need to be thoroughly considered in light of potential for undertesting and delayed testing. Further studies are needed to address the implications of this strategy on patient safety and clusters of transmission.

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/ice.2020.276

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