Use of Computerized Clinical Decision Support for Diagnostic Stewardship in *Clostridioides difficile* testing: an Academic Hospital Quasi-Experimental Study

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INTRODUCTION

Overdiagnosis of *Clostridioides difficile* as a cause of healthcare-associated diarrhea is a prevalent problem in the USA due to increasing use of highly sensitive nucleic acid amplification tests, combined with a low threshold for testing of patients in the absence of significant diarrhea and in the presence of laxatives.[1–3] Others have reported on efforts at reducing unnecessary *C. difficile* testing through computerized clinical decision support (CCDS), with variable results.[4, 5] We conducted a quasi-experimental study to evaluate the impact of CCDS on appropriateness of *C. difficile* testing.

METHODS

This study was part of a quality improvement project at our 750-bed tertiary-care academic hospital, and was determined to be non-human subjects research by the University of Maryland IRB. Among consecutive hospitalized patients undergoing *C. difficile* testing from 2/19/16 to 3/19/16, charts were reviewed for presence of clinically significant diarrhea (i.e., ≥ 3 loose stools in 24 h, or any loose stool with abdominal cramps), laxative use in preceding 48 h, whether an indication for testing was documented, whether testing was done as part of a "sepsis panel," and prior *C. difficile* testing (and result) in the same admission. Testing was considered indicated if the patient had clinically significant diarrhea in the absence of recent laxative use *or* had ileus. In December 2016, four alerts based on diarrhea documentation, laxative use, and prior *C. difficile* tests were placed into the electronic medical record notifying clinicians of potentially unnecessary testing and allowing the opportunity to delete the order. Education and rationale for these alerts were disseminated electronically. Post-intervention data were collected on *C. difficile* orders from 1/21/17 to 2/19/17. Chi-square test was used to compare patient characteristics before and after implementation; $p < 0.05$ was considered significant.

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RESULTS

The pre-intervention group had 280 patients, of which 35 (13%) were positive. Post-intervention group had 167 patients, of which 18 (11%) were positive. Comparing post- to pre-intervention, patients undergoing *C. difficile* testing were more likely to have significant diarrhea (75% vs. 60%, $p = 0.003$) and a documented indication for testing (79% vs. 67%, $p = 0.003$), and less likely to have laxative use in the preceding 48 h (37% vs. 46%, $p = 0.03$), or repeat testing during the same admission (26% vs. 31%, $p = 0.2$.) Testing was frequently done as part of sepsis evaluation and was unchanged post-intervention (33% vs. 32%). Overall, testing was considered clinically indicated in 53% post-intervention compared to 40% pre-intervention ($p = 0.004$).This difference was not statistically significant among only those with positive tests (Table 1).

DISCUSSION

A CCDS-based intervention led to statistically significant decreases in inappropriate *C. difficile* testing but constituted marginal clinical quality improvement (~ 13% in overall appropriate testing). Moreover, nearly 40% of patients reviewed post-intervention had laxative use in the preceding 48 h, and a third underwent testing as part of a broad sepsis evaluation. These results mirror those at another academic hospital system with statistically but not clinically significant reductions in *C. difficile* tests associated with laxative use, and no improvement in *C. difficile* rates with use of CCDS.[4] In contrast, others have reported significant reductions in inappropriate *C. difficile* testing using a "hard stop" intervention,[6] and by coupling education with financial incentives.[5] In review of alert usage (data not presented), we found that alerts were frequently ignored/dismissed, and anecdotally, frontline clinicians held strong beliefs about *C. difficile* testing similar to that observed elsewhere.[3]

Table 1 Characteristics Associated with *C. difficile* Testing Before and After Computerized Clinical Decision Support, University of Maryland Medical Center, 2016–2017

	Pre-intervention ($n = 280$)*	Post-intervention ($n = 239$)*	Chi-square, p value
Positive *C. difficile* test	35 (13%)	26 (11%)	–
≥ 3 loose stools per day	157 (60%)	164 (69%)	0.04
Any loose stool plus abdominal cramping	47 (43%)	62 (57%)	0.02
Clinically significant diarrhea	168 (60%)	179 (75%)	0.04
Testing done as part of "sepsis panel"	87 (32%)	80 (33%)	0.74
Documented indication for testing	188 (67%)	188 (79%)	0.003
Laxative use in preceding 48 h	127 (46%)	88 (37%)	0.03
Repeat testing in same admission	86 (31%)	60 (26%)	0.20
Testing clinically indicated[b] (all patients)	105 (40%)	126 (53%)	0.004
Testing clinically indicated[b] (patients with positive tests)	18 (53%)	18 (69%)	0.20

**Consecutive patients undergoing C. difficile testing reviewed from 2/19/16 to 3/19/16 (pre-intervention assessment period) and from 1/21/17 to 2/19/17 (post-intervention assessment period); denominators may be smaller than the column total due to missing data for some variables*
[b]Testing clinically indicated patient with ileus or patient with 3 loose stools/day or any loose stool with abdominal cramps, in the absence of laxative

Strengths of this study include an in-depth evaluation of appropriateness of testing before and after the intervention. Weaknesses include a single academic center study with small sample size, which did not allow an adequately powered analysis of impact on false positive *C. difficile* cases. A weakness of the intervention itself is the possibility of alert fatigue with CCDS. These findings underscore the importance of arming frontline clinicians with appropriate tools on diagnostic testing, and emphasize the potentially low utility of "soft stops" or alerts in this setting. Indeed, at our hospital, these results led to petitioning for a "hard stop" or cancelation of the order when meeting criteria for unnecessary testing.

In summary, a CCDS-based intervention had limited utility in improving appropriateness of *C. difficile* testing in this single-center study. Additional strategies and qualitative studies of clinicians' decision-making are necessary to improve diagnostic stewardship for this pathogen.

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Compliance with Ethical Standards:

Conflict of Interest: *The authors declare no conflicts of interest.*

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