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The Bristol Stool Scale and Its Relationship to *Clostridium difficile* Infection

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The Bristol stool form scale classifies the relative density of stool samples. In a prospective cohort study, we investigated the associations between stool density, *C. difficile* assay positivity, hospital-onset *C. difficile* infection, complications, and severity of *C. difficile*. We describe associations between the Bristol score, assay positivity, and clinical *C. difficile* infection.

The Bristol stool scale is a graded visual scale of stool density (Table 1) (1). It is validated as a proxy for gastrointestinal transit times (2, 3) and used to define "diarrhea" by the European Society for Clinical Microbiology and Infectious Disease for *Clostridium difficile* infection (CDI) (4). At our institution, we require a specimen Bristol score of ≥5 to reduce inappropriate *C. difficile* testing. Our primary objective was to determine the relationship between Bristol scale score, *C. difficile* assay positivity, and hospital-onset CDI, and specifically, whether specimens of Bristol score 5 could be rejected for a low rate of positivity. Our secondary objective was to compare Bristol scores with rates of complications and severe hospital-onset CDI.

TABLE 1 Bristol stool scale[a]

Score	Description
1	Separate hard lumps, like nuts
2	Sausage-shaped but lumpy
3	Like a sausage but with cracks on the surface
4	Like a sausage or snake, smooth and soft
5	Soft blobs with clear-cut edges
6	Fluffy pieces with ragged edges, a mushy stool
7	Watery, no solid pieces, entirely liquid

[a] See reference 1.

We conducted a prospective cohort study of all stool specimens collected for *C. difficile* testing from adult inpatients at the Hospital of the University of Pennsylvania, a tertiary-care academic hospital, from 1 January 2013 through 31 October 2013. Approval was obtained from the University of Pennsylvania's Institutional Review Board. For refrigerated fresh stool specimens submitted for *C. difficile* testing, the Bristol score was documented in our laboratory information database by one of eight laboratory technologists. Two blinded inter-rater reliability studies were performed in May and July 2013 and analyzed by the Fleiss kappa test. Our *C. difficile* testing algorithm includes enzyme immunoassay (EIA) for glutamate dehydrogenase and toxins A/B (Techlab C. Diff Chek Complete; Alere, Orlando, FL), followed by a nucleic acid amplification test (NAAT) (Illumigene, Meridian Bioscience, Inc., Cincinnati, OH; changed to BD Max, Becton, Dickinson and Company, Sparks, MD, in August 2013) for indeterminate EIA results (glutamate dehydrogenase positive but toxin A/B negative). Internal studies of the relative sensitivities of the Illumigene and BD Max methods showed no significant performance differences. A comparison of the monthly fraction of positive specimens detected by a molecular assay for the same 5-month period (August to December) during 2012 (Illumigene used) and 2013 (BD Max used) showed no significant difference (53% versus 48%, $P = 0.4$ by two-tailed nonpaired t test), concordant with published data on comparative test performance (5). Specimens with a Bristol score of ≤4 were rejected. We collected the assay result, type of assay (EIA or NAAT), date of testing, and patient admission dates from medical records. For positive assays, prospective medical record review was performed by infection preventionists. Cases of CDI were documented in the surveillance program Theradoc (Hospira, Salt Lake City, UT) and CDC's National Healthcare Safety Network (NHSN) database for mandatory state public reporting requirements. For positive *C. difficile* assays sent ≥48 h after hospital admission and from patients readmitted within 14 days of a previous discharge, we determined whether NHSN criteria were met for a gastroenteritis event (6). Repeat assays within 8 weeks of a prior positive assay were excluded. We defined severe hospital-onset CDI by either treatment in the intensive care unit (ICU) for CDI or two or more of the following within 48 h of a positive assay: age of >60 years, temperature of >38.3°C, serum albumin at <2.5 mg/dl, or leukocyte count of >15,000 cells/mm^3 (7). Endoscopic diagnosis of pseudomembranous colitis was not included, as this is not standard practice at our institution nor readily accessible in our medical records. Severe community-onset CDI was not assessed due to poor availability of data. These data, as well as all-cause in-hospital mortality and colectomy for CDI, were collected from medical records. We predetermined a sample size of 2,800 specimens for a power of 80% to detect a difference as small as 4% in the rate of positive *C. difficile* assays between each Bristol group. The proportions of positive *C. difficile* assays, type of assay (EIA or NAAT), location of CDI acquisition, and severity and complications of

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TABLE 2 Results of *C. difficile* assays[a]

Patient group, parameter[b]	No. (%) of specimens with Bristol score of: 5	6	7	*P* value
All inpatients	*n* = 286	*n* = 1,063	*n* = 1,656	
Positive *C. difficile* assay	43 (15.0)	144 (13.6)	177 (10.7)	0.031
Assay used for diagnosis of CDI				
EIA	19 (6.6)	81 (7.7)	106 (6.4)	0.52
NAAT	24 (8.4)	63 (5.9)	71 (4.3)	0.012
C. difficile acquisition				
Community onset	20 (7.0)	64 (6.0)	63 (3.8)	0.007
Hospital-onset CDI	12 (4.2)	51 (4.8)	84 (5.1)	0.80
NHSN CDI criteria not met	8 (2.8)	26 (2.4)	27 (1.6)	0.21
Repeatedly positive specimen within 8 weeks	3 (1.0)	3 (0.3)	3 (0.2)	0.047
Patients with hospital-onset CDI	*n* = 12	*n* = 51	*n* = 84	
Severe CDI[c]	9 (75.0)	34 (66.7)	51 (60.7)	0.22
Complications				
Treatment in ICU	1 (8.3)	2 (3.9)	3 (3.6)	0.74
Colectomy performed for CDI	0 (0)	1 (1.9)	1 (1.2)	0.85
All-cause in-hospital mortality	0 (0)	1 (1.9)	5 (4.9)	0.39
Any complication	1(8.3)	4 (7.8)	9 (10.7)	0.85

[a] Specimens were obtained from January to October of 2013. Semiformed stools are defined as those with Bristol scores 5 or 6; liquid stools are defined as those with a Bristol score of 7.
[b] EIA, enzyme immunoassay; NAAT, nucleic acid amplification test; CDI, *C. difficile* infection; ICU, intensive care unit.
[c] Criteria modified from Zar et al.; other causes of severe illness not excluded.

hospital-onset CDI for patients in each Bristol group were compared using the χ^2 test for trend. Rate ratios and 95% confidence intervals were calculated for comparison of semiformed stools (Bristol 5 or 6) to liquid stools (Bristol 7) using EpiInfo 7 (CDC, Atlanta, GA).

Three thousand five specimens were tested for *C. difficile* during the study. There were 286 (9.5%), 1,063 (35.4%), and 1,656 (55.1%) specimens with Bristol scores of 5, 6, and 7, respectively (Table 2). The average patient ages were 62.9, 59.7, and 55.1 years for Bristol scores of 5, 6, and 7. Seventy-six specimens were rejected for a Bristol score of ≤4. The combined Fleiss kappa score for inter-rater reliability was 0.675. *C. difficile* assays were positive for 43 (15.0%), 144 (13.6%), and 177 (10.7%) specimens with Bristol scores of 5, 6, and 7 ($P = 0.031$). Semiformed stools (Bristol 5 or 6) were more likely to be positive by NAAT than liquid stools (Bristol 7) (6.4% versus 4.3%; relative risk [RR] = 1.50; 95% confidence interval [CI], 1.11 to 2.04). Semiformed stools were more likely to be associated with community-onset CDI than liquid stools (RR = 1.64, 95% CI 1.19 to 2.25). Overall, 147 (4.5%) assays were associated with hospital-onset CDI. The rates of hospital-onset CDI, severe CDI, and complications of CDI did not differ by Bristol score.

The Bristol scale has not been correlated to *C. difficile* assay results or to CDI severity. In this study, *C. difficile* was more common in semiformed stools (Bristol 5 or 6). The lowest rate of detection occurred in liquid specimens (Bristol 7), suggesting that providers may have a lower threshold to test any patient with frankly liquid stools. The highest rate of detection occurred in Bristol score 5 specimens, but these represented less than 10% of all tests. This suggests that Bristol score 5 specimens should not be excluded from testing.

While similar proportions of specimens had *C. difficile* detected by EIA, the proportion of specimens positive by NAAT was almost 50% higher for semiformed versus liquid stools. This may reflect a lower concentration of *C. difficile* toxins or lower *C. difficile* fecal load in semiformed stool and, thus, a higher rate of indeterminate results with EIA.

Overall, 63.9% (94/147) of episodes of hospital-onset CDI were severe, using laboratory and location criteria modified from Zar et al. (7). Endoscopic diagnosis of pseudomembranous colitis was not assessed. These Zar criteria, although not specific to CDI, are associated with treatment failure and CDI relapse. The rates of severe hospital-onset CDI and complications were similar between Bristol score groups.

There are limitations to this study. Our Fleiss kappa score indicates moderate but not optimal agreement on Bristol scores. The use of different testing algorithms or assays may yield different results. We did not assess other methods of classifying stool consistency. This study was not powered to analyze complications in patients with hospital-onset CDI. We did not assess the impact of concurrent *C. difficile* therapy on test results.

Whether clinical laboratories using the Bristol score to determine test acceptability need to perform annual competency training in scoring stool specimens is unclear. Our laboratory provides training in the scoring system as part of *C. difficile* testing training; this includes a test on scoring that is required for competency in performance of the tests. However, we do not perform annual competency testing.

In conclusion, when NAAT testing is used, semiformed stools account for a meaningful proportion of specimens from which *C. difficile* is detected. We see no evidence to raise our current Bristol score threshold for *C. difficile* testing. Whether the testing threshold should be lowered requires further study.

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